FINAL PROJECT – ME141501

TECHNICAL AND ECONOMICAL ANALYSIS INSTALLATION OF UV TREATMENT FOR BALLAST WATER TO ELIMINATE MICROORGANISMS AT MT.SENIPAH ACCORDING TO IMO BWMC

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DEPARTMENT OF MARINE ENGINEERING
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
2017

VALIDATION SHEET

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JULI 2017

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ANALISA TEKNIS DAN EKONOMIS PEMASANGAN *UV TREATMENT* AIR BALLAST UNTUK MENGURANGI MIKROORGANISME DI KAPAL MT. SENIPAH SESUAI DENGAN ATURAN IMO BWMC

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ABSTRAK

Air laut digunakan untuk menjaga keseimbangan kapal selama aktifitas yang mengakibatkan perubahan titik gravitasi kapal seperti proses bongkar dan muat kapal, dan untuk menjaga propeller agar tetap berada dibawah permukaan air laut dan juga menambah kemampuan manouver kapal selama perjalanan. Air laut tersebut sering dinamakan air ballast. Sementara air ballast esensial untuk keselamatan dan efisien untuk operasi, air ballast juga memiliki kerugian karena mengandung bermacam mikroorganisme, seperti virus dan bakteri, larva kecil dan dewasa dan banyak tumbuhan dan hewan laut lainnya. Perpindahan air ballast melalui proses bongkar muat akan secara otomatis memindahkan air ballast dan kontaminannya dari suatu tempat ke tempat lainnya yang memiliki karakteristik perairan yang beda. Pada tahun 2004, IMO menciptakan ballast water management convention, yang mengharuskan air ballast untuk diolah terlebih dahulu sebelum dikeluarkan. UV treatment merupakan metode pengendalian mikroorganisme air ballast yang paling banyak digunakan di kapal. Tujuan dari penelitian ini adalah unutuk memberikan rekomendasi UV treatment yang tepat secara teknis dan ekonomis pada kapal MT. Senipah milik PT. Pertamina (persero). Hasil analisa yang didapatkan adalah alat ballast treatment yang akan diinstall memiliki *power consumption* sebesar 75 kW, namun power consumption tersebut masih dapat dicover oleh generator dengan load factor sebesar 87,7% dengan penurunan flowrate pompa existing sebesar 80 m^3/h sehingga waktu ballasting menjadi 16 jam. Alat ini dapat diletakkan diatas floor deck pada frame 39 hingga frame 43. Analisa ekonomi yang didapat bahwa biaya instalasi peralatan ini membutuhkan dana sebesar Rp 3.222.503.000

Kata kunci : *Ballast, mikroorganisme, UV Treatment, BWMC, IMO*

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TECHNICAL AND CONOMICAL ANALYSIS ON INSTALLATION OF WATER BALLAST UV TREATMENT TO REDUCE MICROORGANISMS IN MT. SENIPAH ACCORDING TO IMO BWMC

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2. Taufik Fajar Nugroho, ST., M.Sc

ABSTRACT

Sea water often used onboard to increase the stability of ship during loading and unloading process which cause a movement of gravity point. This sea water also used to keep the propeller stay below the water and also to increase manouvering ability while sailing. This water is what we called ballast water. While ballast water is very essential for safety and efficient operation, it also brings a disadvantages to the environment because sea water contains variety of microorganisms, like viruses, bacteria, small and adult larval stage and many other plants. The displacement of sea water during loading and unloading process will automatically move the contaminants of sea water to another places which have different characteristics. On 2004, IMO set ballast water management convention which stated that ballast water must be treated first before dicharged. UV treatment is one of methods to treat microorganisms in ballast water which mostly used globally. This bachelor thesis aim to give a correct technical and economical recommendation on the installation of Ballast water treatment equipment on MT. Senipah Data obained from the analysis the power consumption of equipment is 75 kW, meanwhile the power consumption still can be covered by generator with 87,7 % load factor. The decreasing flowrate is about 80 m^3/h, so that the ballasting time will be 16 hours. This equipment could be placed on floor deck in frame 39 – 43. The economical analysis obtained that the installation cost of this equipment is around Rp 3.222.503.000

Kata kunci : *Ballast, mikroorganisme, UV Treatment, BWMC, IMO*

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All praises to the Almighty God, ALLAH SWT, for always bestowing his best blessings for me to get this research done with title ‘’TECHNICAL AND ECONOMICAL ANALYSIS INSTALLATION OF UV TREATMENT FOR BALLAST WATER TO ELIMINATE MICROORGANISMS AT MT. SENIPAH ACCORDING TO IMO BWMC’’. This bachelor thesis presented to comply the requirements to get bachelor degree in Depratment of Marine Engineering, Faculty of Marine Technology, ITS.

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9. All member of Robotic Boat Competition comitee
10. All member of Marine and Machinery system
11. Barakuda 13, my familiy in Department of Marine Engineering
12. All graduation friends 115 in Department of Marine Engineering

And all of friends and families I could not stated here. I realize that this thesis is still far from perfect and has many shortcomings. So with all humility, suggestion and good critisisms from the readers is needed.

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CHAPTER I
INTRODUCTION

1.1. Background Study

Water which was taken from the sea to maintain the stability of a ship during loading and unloading process and when the ship sails on empty condition we call ballast water. In addition to maintaining the stability of the ship, the ballast water also serves to keep the propeller to stay below the water line and to improve the manouvering ability of ship during sailing. Then when the ship sails in full load condition, then the ballast water will be pumped out. 85% of world trade is done by sea, meaning that in every year there is tons of ballast water moved from one region to another region along with the migration of microorganisms, viruses, bacteria, as well as marine plants and animals at adult or larval stage (IMO,2000)

These materials often contain harmful species that can disrupt the ecological and economic balance of the objective environment. Dreissena Polymorpha or zebra mussel is one of the invasive species that attacked lakes in Texas, USA. This species is a type of parasitic shell commonly found under the hull of a ship and eat algae which is a food of fish. The owner of the ship must spend at least 50 billion per year just to clean the hull of the ship due to the attack of this species. Even worse, fish catches in Argentina's cape valdes area decreased by 4000 tons in 1993 due to the species Mnemiopsis leidyi or commonly called jellyfish comb. In addition, the deadly disease caused by the bacterium vibrio cholerae has killed ten thousands of people in South America in 1994. The spread of these species is very easy to do through the sea. Therefore, the process of moving ballast water will greatly affect many things, not only ecology but also economy and health. (Nihlawati, 2008)

Regarding this issue, in February 2014, IMO issued the International Convention for the Control and Management of Ships' ballast water and sediments (BWMC) regulations. This regulation establishes a framework or reference for their respective state governments to implement the new regulations. IMO Regulations on Ballast water management convention applies to all types of vessels designed to carry ballast water that also uses the flag state of a convention member.

There are various of additional components in the vessel to overcome the issues and regulations that have been developed, one of which is the addition of ballast water treatment system using ultraviolet. The addition of this equipment is due to the rules that will come into force in 2017, namely the BWMC (Ballast Water Management Convention) which standardizes that the ballast water must be treated first before being removed from the vessel.

The reason why on choosing UV Treatment is because Ballast water management convention stated that the treatment system should get type approval whether from classification society or any other society. Most of UV Treatment sold in market already gained type approval from class and it is the most used treatment system onboard. And for any other reasons will be discussed further in literature review

The purpose of this research is to be used as a reference for the installation of ballast water treatment technology on the ship MT. SENIPAH belongs to PT. PERTAMINA (Persero), which previously did not have an equipment of ballast water treatment and also to kill microorganisms in accordance with IMO regulation on ballast water management convention 2004, which will be forced to start in September 2017 after this regulation was adopted by more than 35% GT world.

1.2. Formulation of problems

In order to finish this research, tha autor set the formulation of study as below :

1. How is the design related to the addition of ballast water treatment installation ?
2. What are the changes in the ship's previous system due to the installation of ballast water treatment equipment ?
3. How to analyze the estimation cost of the installation of ballast water treatment ?

1.3. Scope of problems

Scope of problems of this research are :

1. System discussed is only concer on ballast system
2. Treatment method is using UV Treatment
3. Did not discusses in detail about engine room
4. Economic analysis is only up to the procurement cost and installation cost of ballast water treatment

1.4. Research Objectives

Objectives from this research is to :

1. To design the new system related to the installation of ballast water treatment
2. To describe the modification of the existing system due to the application of ballast water treatment
3. To estimate the installation cost of ballast water treatment at MT. Senipah owned by PT Pertamina

1.5. Research Benefits

To give a recommendaition on choosing the right treatment system installed at MT. Senipah owned by PT Pertamina

CHAPTER II
LITERATURE REVIEW

2.1. General Review

Sea water and sediments brought into the ship's tank as a stability enhancer have been identified as the largest cause of the spread of invasive microorganisms in the world's waters (werschkun et al., 2014). Ships often carry water ballasts at a port and take them out at other ports. Transport by sea is estimated to be 90% of the world trade route (Globallast, 2006).

Establishing a proper ballast water management strategy is an essential issue today in reducing the spread of invasive microorganisms in the world's waters. Therefore, the International Maritime Organization in 2004 issued the Ballast Water Management Convention (IMO, 2004) which will come into force in 2017 after being ratified by 52 contracting parties and covering 35% of the world's GT (Globallast, 2016). This will be a significant step in tackling the problems for contolling invasive microorganism. Currently there are only 2410 vessels equipped with BWTS (IMO, 2015) equipment with a wide range of configurations, the most widely used is the combination of filtration with chemicals (Lloyd's Register, 2014).

In order to meet sustainable (eco-friendly and cost-effective) strategies that reduce the use of hazardous chemicals (Rivas-Hermann et al, 2015; Werschkun et al, 2012), studies on the use of different methods are beginning to emerge, one of them is by using UV (Ultraviolet) rays (Su et al, 2014)

UV light technology is based on the principle of light absorption by organic molecules (Su et al, 2014) like DNA; So the method is known as the disinfection method (Hijnen et al, 2006).

2.2. Ballast System

Ballast is a system that is used to maintain the stability of the ship due to change of gravity points that are often cultivated during the loading and unloading process. The process of filling and discharging on the ship will be followed by filling and discharging the ballast tank as well. When the vessel is empty, the ballast will be put into the ballast tank to replace the amount of weight lost due to the empty load condition. Whereas if the load is full, the ballast water will be discharged through the overboard. In the filling process from the origin port, microorganisms contained in ballast water will be automatically transferred to the destination port which will cause disturbance and imbalance of ecosystem in the environment of the destination port

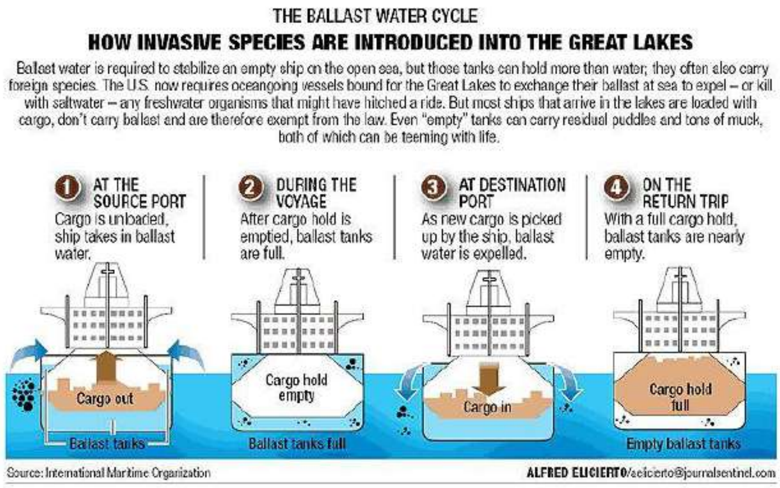

Figure 2.2-1 Ballast water transferring process

Ballasts water are carried by ships and loaded in storage tanks or called ballast tanks. The complexity of the ballast system operation depends on the size, configuration, and requirements of the vessel and the complexity of the pump and its piping system. The ballast capacity can range from a few cubic

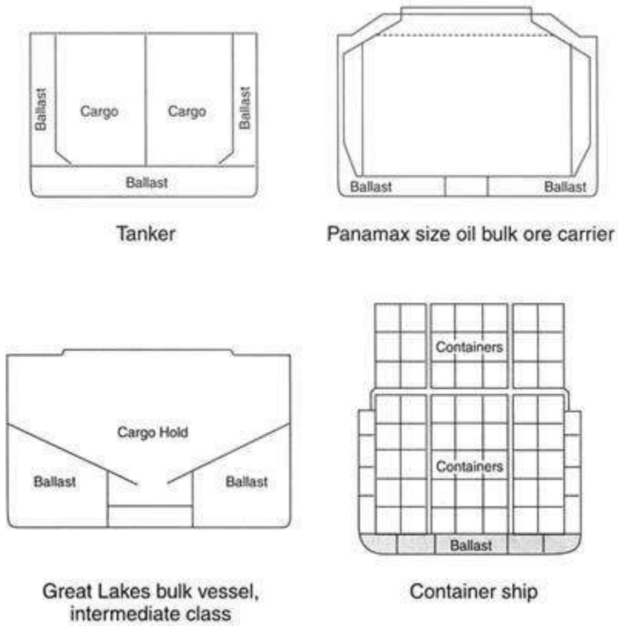

Figure 2.2-2 Type of ballast water for kinds of vessel

meters on a small boat to cubic meters on large cargo ships. [1]

Ballast system which was pumped in to the ballast tank has many functions. They are :

- Reduce the stress in ships hull
- Give additional stability

- Help the propultion system to control the propeller to stay below the waterline
- Help the maouvering ability and reduce the amount of hull which come at the surface
- Compensate the cause of ships weight reduce because of fuel and water while consume

Ballast water is pumped into the ship through seachest with the help of ballast pump. Seachest could be located below the ship and usually placed at the bilge turn or placed beside ship in each side. Ballast system works in reverse when deballasting that is through the overboard line. Seachest is equipped with grating or strainer which has a function to protect the pump system from contaminants that comes into the system

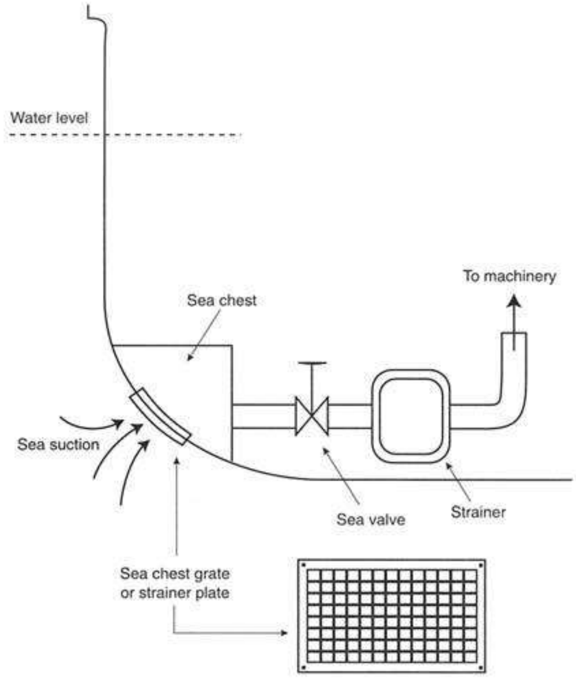

Figure 2.2-3 Seachest and its components

In designing ballast syetms, there were few things to be considered, such as the calculation of the pump, the capacity needed , the head of the pump and spesifications of pipe choosen and etc.

$D_{in} = \frac{4Q}{\sqrt{v\pi}}$ [m]..1

Description : D_{in}= Inside diameter
Q= Pump capacity
v= flow velocity (2-3m/s)

source. BKI Vol. III Sec 11

$$Q = \frac{Volume\ of\ ballast\ tank}{Time\ neede\ for\ ballasting} \text{.................................2}$$

$$Volume\ of\ ballast\ tank = \frac{10-15\%\Delta}{\rho}\ [\mathrm{m}^3] \text{.......3}$$

Description : Δ= Displasment of ship

ρ = Density of sea water

$$Hpompa = Hp + Hv + Hs + Hloss\ [\mathrm{m}] \text{ ....4}$$

source. Modul praktikum mesin fluida T. Sistem Perkapalam-ITS

Description : Hp= Head Pressure

Hv = Head Velocity

Hs = Head Statis (T+0.75)

H loss = Head loss suction – Head loss discharge

2.3. Impact of Microorganisms Displacement

When ballasts water are discharged at the destination port, many microorganisms and sediments enter the ballast tank. Many of these microorganisms survive in the tank, and when expelled, these microorganisms enter new aquatic environments. If the condition of the water of destination is good enough, these microorganisms can survive and reproduce so that it can become an invasive species that disturbs the balance of ecosystem in the territorial water area. Australia and Canada are the first countries to feel the impact of the emergence of invasive species of microorganisms through the ballast water. The impact is not just the impact of environmental pollution, but also the health and economic impact.

<u>Environmental impact</u>

One example of the environmental impact caused by this invasive microrgansime is fish catch in Argentina's cape valdes area decreased by 4000 tons in 1993 due to the species of Mnemiopsis leidyi or commonly called jellyfish comb

Figure 2.3-1 Menmiopsis leidyi

Health Impact

The deadly disease caused by the bacterium vibrio cholerae has killed tens of thousands of people in South America in 1994.

Economic Impact

Dreissena Polymorpha or zebra mussel is one of the invasive species that attacked lakes in Texas, USA. This species is a type of parasitic shell commonly found under the hull of a ship and eat algae which is a food of fish. The owner of the ship must spend at least 50 billion per year just to clean the hull of the ship due to the attack of this species

Figure 2.3-2 Zebra Mussel as an Invasive species

2.4. Control of Microorganisms

IMO defines ballast water treatment equipment as an apparatus that aims to reduce the growth of microorganisms, viruses, bacteria, due to ballast displacement either mechanically, physically, chemically,

The process of controlling microorganisms is a vital step that must be done immediately considering the impact will be very disadvantageous to many parties. Microorganisms contained in the water ballast include:

a. Autotrof microbes
b. Heterotrof Microbes
c. Bactery
d. Fungi
e. Microalgae
f. Viruses
g. Protozoa

There are various methods to treat ballast water. Many technologies have been developed to reduce the spread of invasive spesies as shown in the picture below :

2.5. UV Treatment

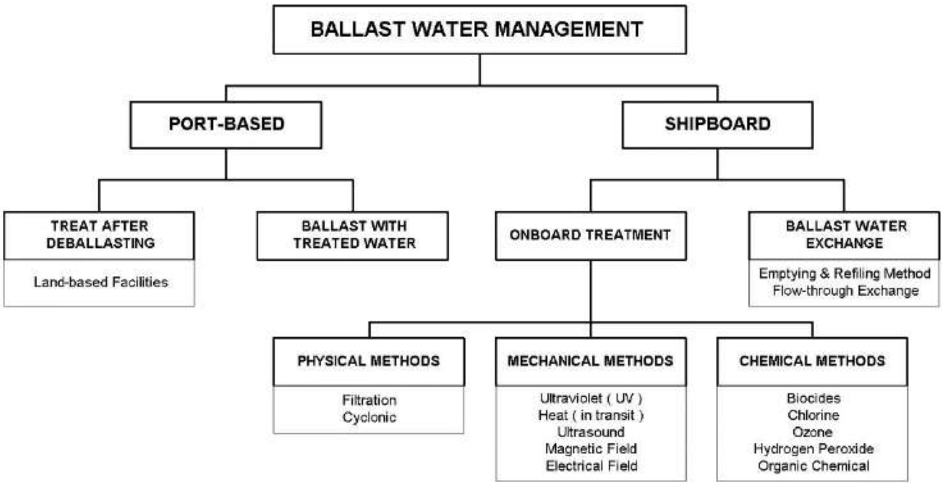

Figure 2.4-1 Methods to treat ballast water

The ballast water treatment method using UV radiation consists of UV lamps that surround a room or place in UV Chamber where the ballast water will be passed. UV lamps (Amalgam lights) will produce ultraviolet light that will react to the DNA of microorganisms in the water ballast and make them harmless and prevent reproduction of the microorganism. This method is successfully used globally for the purpose of filtering and treating water prior to removal.

Ballast water treatment methods using UV radiation are often combined with filtration methods before entering the UV chamber.

It is necessary to filter microorganisms over 50 µ in order to increase the effectiveness of the UV treatment process. The treatment process takes place during ballasting and de-ballasting.

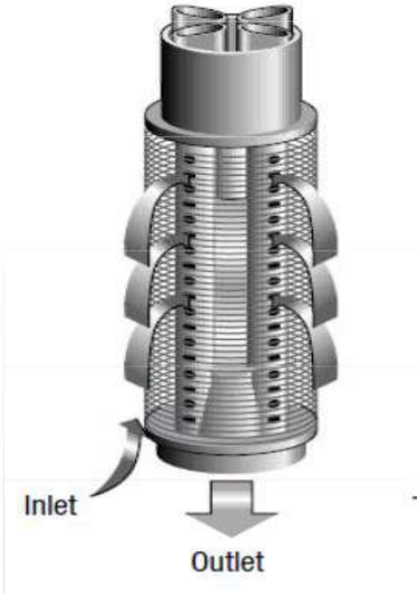

Figure 2.5-2 Stacked disc filter design

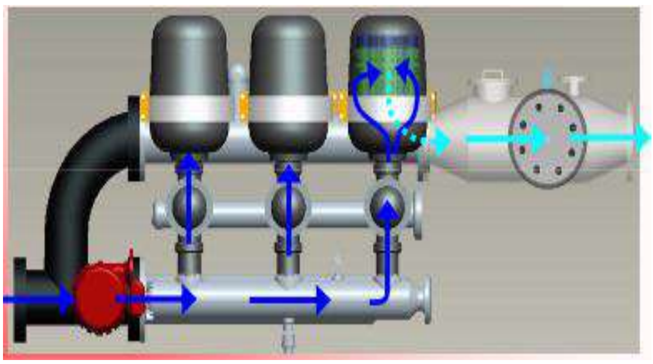

Figure 2.5-3 Filtration and UV radiation process

Ultraviolet radiation requires the process of all water ballasts without the need for holding time because the treatment is completed after the ballast water passes through the equipment. (ABS, 2014)

Selection of the use of ultraviolet rays is due to some advantages that are not found in other systems, including: [2]

- Environmentally friendly, no hazardous chemicals and no overdose problems.

- Low start-up capital costs and reduced operating costs when compared to the same technology as ozone, chlorine, etc.
- Very economical. Comparing with other methods, for example heating
- Low power consumption.
- Safe to use.
- No useful mineral removal.
- No change in taste, odor, pH or conductivity or chemical elements of water.
- Automatic and friendly operation.
- Simplicity and ease of maintenance.
- No handling of toxic chemicals, no need for special storage requirements.
- Easy installation

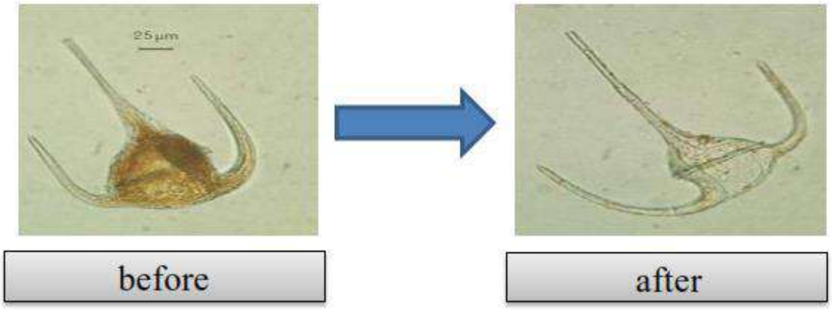

Figure 2.5-4 Effect of UV radiation to the DNA of Microorganisms

2.6. Ballast Water Management Convention

Scientists first became aware of the signs and effects of invaisve species by microorganisms from this ballast water after the discovery of Algae Odontella Asia (Biddulphia sinensis) in the North Sea in 1903. In the late 1980s, Canada and Australia were among the most abundant countries having problems regarding alien species entering the surrounding waters and bringing this issue to the IMO.

The management of ballast water treatment has received special attention in the last decade. This is supported by research that has been done on selecting the right technology to treat the ballast water. According to the Ballast Water Management Convention, IMO has established several regulations related to ballast water namely D1 (Ballast water exchange standard) and D2 (Ballast water performance standard). (IMO, 2005). This regulation sets the standard number of marine microorganisms that live by size. Organisms of greater than or equal to 50 µm typically represent zoo-plankton, and organisms that are between 10 µm to 50 µm can be classified as phytoplankton. Using two categories of microorganisms will be very meaningful in the research conducted.

Table 2.6-1 IMO D-2 Standard performance

Organism Category	Standard
Organism size > 50 µm	< 10 viable organism/mL
10 µm < Organism Size < 50 µm	< 10 viable organism/mL
Organism size < 10 µm (including the following items)	
Toxicogenic Vibrio Cholerae	< 1 cfu/100 mL
E. Coli	<250 cfu/100mL
Intestinal Enterococci	<100 cfu/100 mL

2.7. Engine Room Layout Planning

The design of the engine room is a work related to the layout of machinery and machinery with all the fittings and what is designed in the room, so that the optimum design results obtained in accordance with applicable regulations without abandoning the art aspect of the design, as well as obtaining the optimum relationship between machines with other machines, machines with humans and between humans and other humans.

One thing to keep in mind, is that machines and all equipment used on ships and other marine buildings must meet certain requirements different from those used on land. Therefore we then recognize the term called marine used for application in the sea and land used for land. [3]

Things to be considered in marine used are :

- Environmental condition
- Area or volume of room or spaces
- Relationship between engine room and foundations of engine
- Relationship betweeen engine and other machineries with human

<u>Size of Engine room</u>

Length of engine room

One important point in the early stages of design is to determine the length of the engine room, because it determines the overall length of the vessel, which further affects the shape of the ship, performance, structure and so on. Beyond the consideration of ease of access and maintenance, the length of the engine room should be as short as possible, because the longer the engine room, the heavier the construction, and the less capacity (space) fit.

Height of engine room

Engine casing should be made high enough for maintenance and overhaul of the main engine. In general, the piston of the main engine is periodically held maintenance and replacement so need to be removed, for the purposes of this piston expenditure required enough space or high engine casing should be enough to support this work.

Layout of engine room

As mentioned before, it is very important to create an initial planning layout to determine the effect of the selection of propulsion on the configuration or arrangement of spaces for machining. To plan the engine room the entire system needs to be determined in detail. In the design consideration of the engine room not only minimize the volume of engine room or the length of the engine room but should be considered the achievement of a rational layout for the main engine and auxiliary machines. It should also be considered the possibility of installation, operation, practical maintenance, reparation or replacement.

2.8. Technical and Economic Analysis

Technical and economy analysis is a blend of economics and engineering. It is used as a tool to determine the feasibility of a project as well as to evaluate policy-making in economic terms. With this tool the study and study of ideas is translated into a form of development projects, analyzed and then emerged to various alternatives and recommendations that are economically feasible.

Assuming that technical economics can be used by policy makers, investors, practitioners and other experts involved in development engineering. [4]

Basically, technical economics involves the process of formulating, estimating, and evaluating economic outcomes after alternatives to achieve a particular goal . So it can be said that the technical economy is a collection of mathematical calculation techniques that simplify comparison in terms of economics. [5]

Many engineering / engineering projects are in realization often faced with alternative choices such as design, procedures, methods and so on. The related economic aspects of this analysis include:

- Investment cost or fixed cost
- Operating costs
- Overhead cost
- Etc

In this case that will be analyzed is the investment cost of the addition of a ballast water treatment tool .

CHAPTER III
RESEARCH METHODOLOGY

3.1. Research methodology

3.1.1. Approach and type of research

The research method is a method used to answer the problem in detail which include the variables studied, research design used, data collection techniques, data analysis techniques, how to interpret and conclude the research (Sarwono, J. 2006). This is often referred to as a tool for truth-seeking.

In this thesis research, approach method used is quantitative method. This is because this research is measurable, objective, and rational. Unlike qualitative research that tend to be subjective and not patterned.

3.1.2. Object of reserach

Object of research in this thesis is MT. Senipah owned by PT Pertamina (persero)

3.2. Research stages

The methodology used in this research is as follows:

3.2.1. Literatur review

The first stage in this study is to conduct literature studies. The literature study is about ballast system, water ballast treatment tool, and MT. Senipah engine room design.

3.2.2. Data collection

Data collection methods conducted in this study is through direct observation to the first party or through various types of other sources.

Table 3.2-1 List of data needed in this research

No.	Type of data	Number	Resource	Primary/secondary	Method
1.	*Principal particular of ship*	1	PT Pertamina (persero) perkapalan	Primary	Observe
2.	*General Arrangement of ship*	1	PT Pertamina (persero) perkapalan	Primary	Observe
3.	*Engine room layout*	1	PT Pertamina (persero) perkapalan	Primary	Observe
4.	*Keyplan of ballast system*	1	PT Pertamina (persero) perkapalan	Primary	Observe
5.	Spesification of existing ballast	1	PT Pertamina (persero) perkapalan	Primary	Observe

	system				
6.	Spesification and data of main generator	1	PT Pertamina (persero) perkapalan	Primary	Observe
7.	Spesification of UV treatment equipment	2	Journal or spec	Secondary	Through spec
8.	Electric load analysis		PT Pertamina (persero) perkapalan	Primary	Observe

3.2.3. Data analysis

Technical Analysis

At this stage , steps to be conducted will be a technical analysis of the design of the ballast system in the ship. With the installation of UV ballast treatment will definitely change the design of the ballast system. So it requires technical analysis to conform to the technical standards that have been sought in the literature study phase. In addition to the design of the ballast system, at this stage will also be analyzed the addition of any equipment needed to support the system to function optimally so as to meet the established standards.

Economic analysis

At this stage will be analyzed the selection of equipment that support the work of the ballast system to the maximum with such treatment from an economic point of view. It aims to reduce production costs incurred.

3.2.4. New system planning

At this stage, the author will design new ballast water treatment system and also redesign the ballast system available on board. This system design model uses autocad.

3.2.5. Conclusions and recommendations

The final step in the preparation of this final task is to make a conclusion of the whole process done before and provide answers to existing problems.

3.3. Research scheme

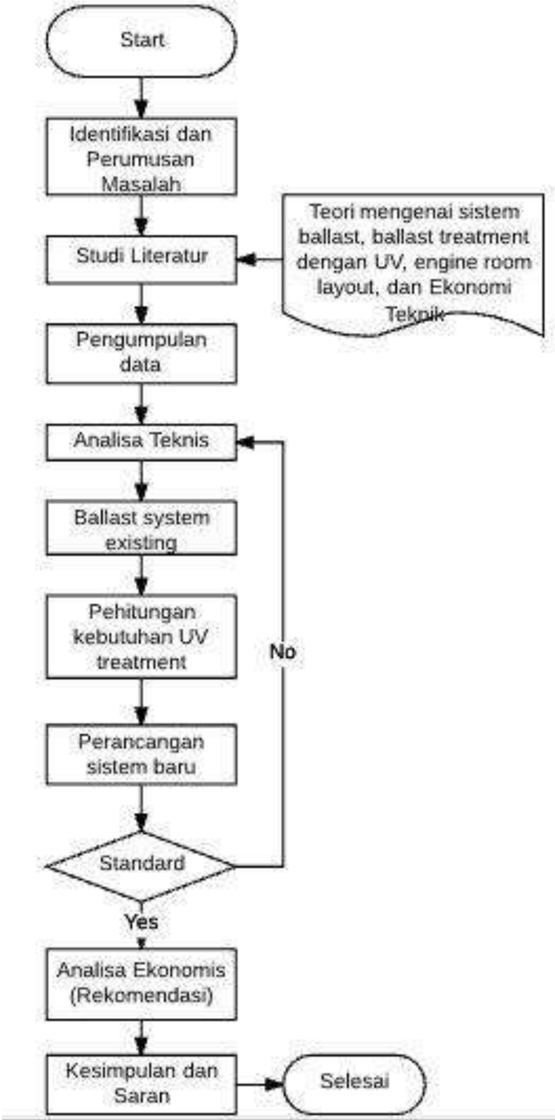

Figure 3.3-1 research scheme

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CHAPTER IV
DATA ANALYSIS AND RESEARCH FINDINGS

4.1. Principal data of ship

Name of ship	: MT. Senipah
Lpp	: 173 m
Loa	: 180 m
B	: 30,5 m
T	: 9 m
H	: 15,9 m
Vs	: 14 knot
Deadweight	: 29760,2 ton
Route	: Tuban (IDN) – Singapura (SG)

4.2. Data of Main Engine and Main Generator

Spesification of main engine is as below :
MAN B&W 6S42MC7

Name of engine = MAN B&W
Serial no. Of engine = 6S42MC7
Power = 6480 kW
Number of Cylinder = 6
Description = IMO TII 2 - Stroke engine
Engine rotation = 136 rpm
Piston Stroke = 1764 mm
Mean Effective Pressure = 19,5 bar
SFOC = 179 g/kWh
No. Of main engine = 1

Spesification of Generator set

Name of Genset = Anqing-Daihatsu
Serial number = 6DK26
Genrator capacity = 1300 kW
No. Of poles = 10
Voltage phas frequency = AC 450V 3 Phase 60Hz
No. Of genset = 3

4.3. Spesification of existing system equipments

Ballast system in this ship is supported by two ballast pump with spesification given below :

Name of pump = Wartsila Hamworthy

Model = CAC300-15 H48 AAN
Capacity of pump = 650 m^3/h
Head of pomp = 25 m
Number of pump = 2
Type = Double suction, One stage, Axially split, Centrifugal pump
Diameter of Main pipe= 330,2 mm
Diameter of branch pipe= 313,9 mm

4.4. Ballast tank capacity

Table 4.3-1 Capacity of ballast Tanks

WATER BALLAST TANKS			
COMPARTMENT	LOCATION (FRAME)	CAPACITY (m^3)	WEIGHT
		100% Full	TON
F . P . T. (C)	96 - F.E	1231,68	1262,47
NO. 1 W . B . T (P)	89 - 96	1480,55	1517,57
NO. 1 W . B . T (S)	89 - 96	1548,36	1587,07
NO. 2 W . B . T (P)	82 - 89	1303,59	1336,18
NO. 2 W . B . T (S)	82 - 89	1407,25	1442,43
NO. 3 W . B . T (P)	75 – 82	1251,91	1283,2
NO. 3 W . B . T (S)	75 – 82	1356,1	1390
NO. 4 W . B . T (P)	68 – 75	1251,91	1283,21
NO. 4 W . B . T (S)	68 – 75	1356,1	1390
NO. 5 W . B . T (P)	61 – 68	1243,28	1274,37
NO. 5 W . B . T (S)	61 – 68	1347,47	1381,16
NO. 6 W . B . T (P)	50 – 61	1351,04	1384,82
NO. 6 W . B . T (S)	50 – 61	1458,95	1495,43
A . P . T. (C)		653,877	670,224
TOTAL		**18205,7**	**18660,8**

Based on the data obtained, we can calculate the time needed for ballasting and deballasting process by dividing the total volume of ballast tank by the capacity of the pump installed.

$$Q = \frac{V}{t}$$

$$t = \frac{V}{Q}$$

$$= \frac{18205{,}7\ m^3}{1300\ \frac{m^3}{h}}$$

$$= 14\ h$$

So the time obtained in the process of ballasting and de-ballasting is 14 hours.

4.5. Selection of Ballast water treatment system

In designing the selection of ballast water treatment there are several factors or considerations that must be considered are the flowrate, power required, and the size of the equipment. For the flowrate of the ballast water treatment it should fit or exceed the capacity available by the pump already installed for the treatment system to work properly.

Power consumption of the equipment is also a prior consideration to the installation, because if the power from the generator is not sufficient then it is necessary to replace the generator set.

The size of the equipment must also be adjusted to the available space on the engine room so that if there is insufficient available space , it is necessary to consider the transfer of other equipment in the engine room.

Here's a comparison of some specifications maker that has been

Table 4.5-1 Comparison of ballast water treatment maker

		HYDE GUARDIAN HG250G	WARTSILA AQUARIUS UV	ARA PLASMA ARA-028	ALFA LAVAL PUREBALLAST
Country		United Kingdom		Republic of Korea	Norway
Methods of Treatment		Filter + UV Radiation	Filter + UV Radiation	Filter + Plasma + UV Radiation	Filter + UV Radiation
Flow Rate (m3/h)		700	750	800	750
Power Consumption (kW)		75	93,2	75,8	120
Size	**Filter**	1030x630x1980	3700x1300x2500		610x637x1296
	UV Reactor	1110x630x1120	2600x1200x900	1060x810x878	855x765x1400
	Power Panel	1200x405x1800	1200x500x2000		1350x610x2000
	Control Panel	600x210x760	300x1000x1000	1300x800x1500	650x310x1100
Pressure Drop (bar)		0,7	0,8		
Total Weight (kg)		2000	4175	2146	1515
Type Approval		LR Type Approved	-	KR Type Approved	-
		IMO Type Approved	IMO Type Approved	IMO Type Approved	IMO Type Approved
		USCG AMS Approved	USCG AMS Approved	USCG AMS Approved	USCG AMS Approved
Capital Expenditure		-	-	-	-

adjusted with the available pump flowrate

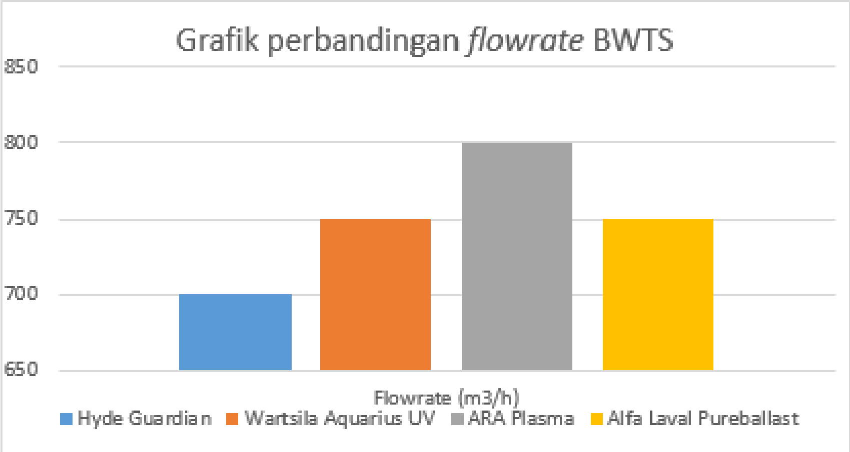

Figure 4.5-1 Comparison of flowrate

From the graph above can be seen that Hyde Guardian has the most optimal flowrate suitability with pump flowrate that is equal to 700 m3 / h. Appropriate flowrate is required because the UV system designed on each device is adjusted to the flowrate through the tool. UV dosage or energy released by UV rays (mW / cm2) to deactivate DNA from microorganisms is adjusted, among others, to the flowrate system, the intensity of the lamp, and the time of the exposure.

From the graph above it can be seen that Hyde Guardian has the least power requirement compared to other BWTS maker that is equal to 75 kW for

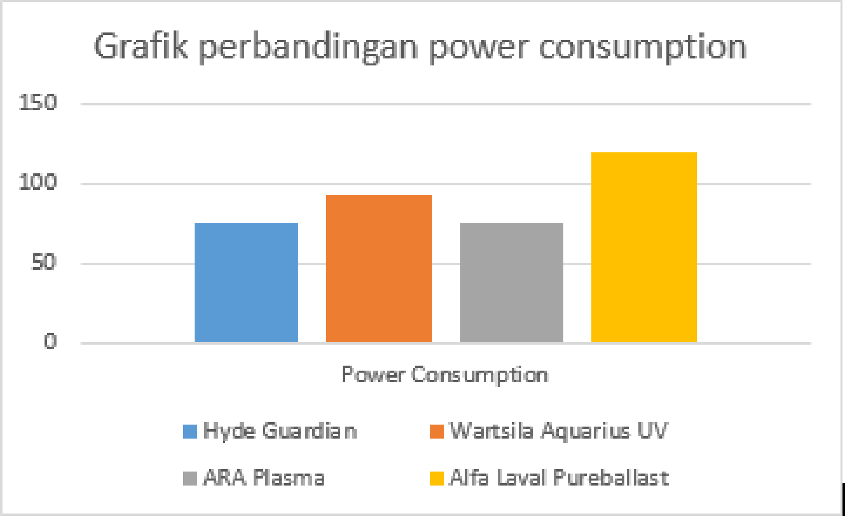

Figure 4.5-2 Comparison of power consumption

each equipment installed . On MT. Senipah, there are two ballast treatment equipment to be installed so the total power required is equal to 150 kW. The power consumption of the treatment device must be adjusted to the adequacy of the power available by the main generator set.

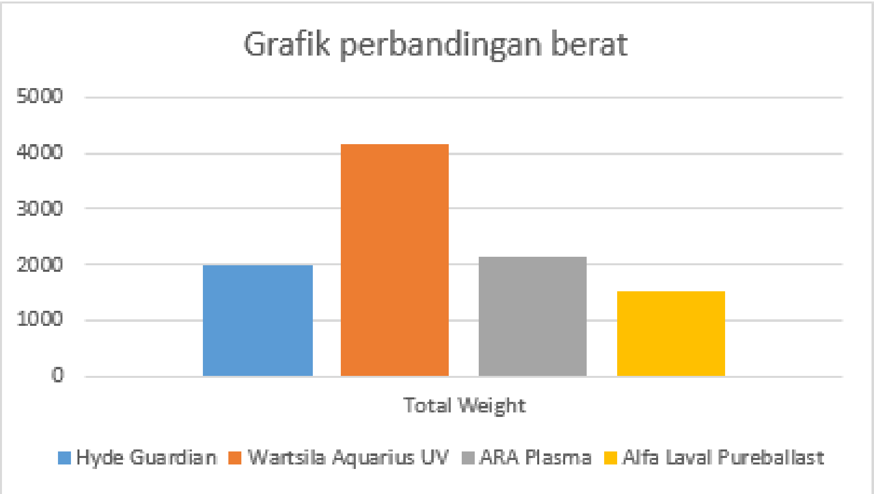

Figure 4.5-3 Comparison of weight

From the graph above it can be seen that Alfa Laval Pureballast has the lightest total weight equipment compared to other treatment tools that is equal to 1515 kg. Equipment that is too heavy will disrupt the stability and structural strength of the ship

Besides the considerations mentioned above (ABS,2014) there were also several things to be considered on choosing the right ballast treatment system as mentioned below :

.

1. *Proven efficacy and official approvals*
2. *Vendor qualifications and reputation*
3. *Maintenance requirements and system reliability*
4. *Simple operation and control monitoring*
5. *Life cycle costs*

Looking at the predetermined considerations, the chosen tool with the most optimum suitability is Hyde Guardian Ballast Water Treatment with the following specifications

Hyde GUARDIAN Gold™ BWTS	Max Flow (m^3/hr)	Filter Model #	UV Model #	Power (KW) nom/max/BW
HG60G	60	FC100	UV8B	7/10/5
HG100G	100	FC150	UV16A	10/15/5
HG150G	150	FC150H	UV16A	10/15/5
HG250G	250	FC200	UV16B	18/25/10
HG300G	300	FC200H	UV16C	24/34/10
HG450G	450	FC250	UV20A	36/50/10
HG500G	500	FC250	UV20A	36/50/10
HG600G	600	FC300	UV20A	36/50/10
HG700G	700	FC300	UV20B	53/75/10
HG1000G	1000	FC400	UV20B	53/75/10
HG1250G	1250	FC450	UV20C	78/114/10
HG1500G	1500	FC450	UV20C	78/114/10
HG2000G	2000	FC500	UV20B x 2	106/150/10
HG2500G	2500	FC600	UV20C x 2	156/228/15
HG3000G	3000	FC600	UV20C x 2	156/228/15
HG4000G	4000	FC500 x 2	UV20B x 4	212/300/20
HG5000G	5000	FC600 x 2	UV20C x 4	312/456/30
HG6000G	6000	FC600 x 2	UV20C x 4	312/456/30

Figure 4.5-4 Spesification of hyde guardian

Figure 4.5-5 Hyde Guardian UV

4.6. Calculation of generator load

Spesification of main generator set installed onboard is as follows:

Table 4.6-1 Spesification of main generator

	NO. 1 GENERATOR	NO. 2 GENERATOR	NO. 3 GENERATOR	EM'CY GENERATOR
MODEL/TYPE				
RATING	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS
OUTPUT	1625 KVA(1300KW)	1625 KVA(1300KW)	1625 KVA(1300KW)	187,5 KVA(150KW)
POWER FACTOR	0,8	0,8	0,8	0,8
VOLTS	AC 445 V	AC 445 V	AC 445 V	AC 445 V
AMPERES	2108,3 A	2108,3 A	2108,3 A	2108,3 A
NO. OF PHASES	3 PHASES	3 PHASES	3 PHASES	3 PHASES
FREQUENCY	60 HZ	60 HZ	60 HZ	60 HZ
NO. OF POLES	10P	10P	10P	4P

Table 4.6-2 Generator load calculation for each condition

		NORMAL SERVICE	DEP. & ARR/PORT	NAV. WITH TANK CLEAN	CARGO SERVICE	HARBOUR SERVICE	EM'CY SERVICE	
							BLACKOUT	FIRE
CONTINUOUS LOAD (KW)		500,4	500,4	625,3	1727,4	225,6	102,1	117,5
INTERMITTENT LOAD	TOTAL (KW)	522,1	649,4	512,8	639,8			
	DIVERSITY FACTOR	1,5	1,5	1,5	1,5	1,5		
	REQUIRED POWER	348,0	432,9	341,8	426,5	382,1		
TOTAL REQUIRED POWER (KW)		848,4	933,3	967,1	2153,9	607,7	102,1	117,5
OUTPUT OF GENERATOR (KW)		1300 KW x 1	1300 KW x 1	1300 KW x 1	1300 KW x 2	1300 KW x 1	150 KW x 1	150 KW x 1
LOAD FACTOR OF GENERATOR		65,3%	71,8%	74,4%	82,8%	46,7%	68,1%	78,3%

Water ballast treatment is planned to be held at Cargo service, so the addition of this tool will affect the power requirement during cargo handling

Power Output = 75 kW (*Intermittent load*)

Efficiency = 0,95

Power Input = $\frac{\text{Power output}}{\text{Efficiency}}$

Power Input = 78,94 kW

Load factor = 0,80

Total Load = 2

$Power\ (IL) = Load\ factor\ x\ total\ load\ x\ Input\ daya$

$Power\ (IL) = 0{,}8\ x\ 2\ x\ 78{,}94$

$Power\ (IL) = 126{,}304\ kW$

Thus, if the tool is added then the need for electricity during the cargo handling will be increased from 2153.9 kW with load factor 82.8% to 2280.2 kW or with load factor of 87.7%. The power needed during operation can still be covered by two generators of 2600 kW.

However, in practice at start conditions, all rotating engine components tend to have a 3 times current flow of normal currents. The start current is proportional to the power at a constant voltage. In other words, if the current start is at 3 times of the nominal current then it is equivalent to 3 times the power of the equipment. Thus, to anticipate the start current on the equipment that has the greatest power in this case is the cargo pump, it is necessary to do the start flow analysis as follows:

Ship type	= Tanker
Cargo Handling Equipment	= Cargo Pump (3)
Power @cargo pump	= 575 kW
Load factor cargo pump	= 0,85

$$Total\ load\ loading\ and\ unloading = Total\ power\ load - total\ cargo\ pump\ power$$

$$Total\ load\ loading\ and\ unloading = 2280{,}2 - 1725$$

$$Total\ load\ loading\ and\ unloading = 555{,}2\ kW$$

$$Start\ power\ for\ 1\ pump = [1\ x\ (Power\ of\ Crane\ \ x\ lf.Crane)] + [3\ x\ (Power\ of\ crane\ \ x\ lf.Crane)]$$

$$Start\ power\ for\ 1\ pump = [1\ x\ (575\ \ x\ 0{,}85)] + [3\ x\ (575\ \ x\ 0{,}85)]$$

$$Start\ power\ for\ 1\ pump = 2443{,}75\ kW$$

$$Start\ power = The\ total\ load\ of\ loading\ and\ unloading\ (without\ pump) + The\ start\ for\ 1\ pump$$

$$Start\ power = 555{,}2 + 2443{,}75$$

$$Start\ power = 2998{,}95\ kW$$

$$Lf\ 3\ generator = \frac{Start\ power}{3\ x\ Power\ Generator}$$

$$Lf\ 3\ generator = \frac{2998{,}5}{3\ x\ 1300}$$

$$Lf\ 3\ generator = 77\ \%$$

So to anticipate the start current, at the starting point it is recommended to use 3 available generators. Thus, the load factor for the 3 generators becomes 77%. After all equipment of cargo handling is turned on, it can be switch back to use 2 available generator .

4.7. Modification scenario of piping systems

The addition of new tools to the ballast system that has been installed gives the impact of changes to the piping system of the previous system. In the installation planning, the selected treatment equipment will be placed after the ballast pump path. In the ballasting process, the seawater that is pumped in by the ballast pump will go through the filtration process first before entering the UV chamber.

In the deballasting procees, ballast water from ballast tanks will be

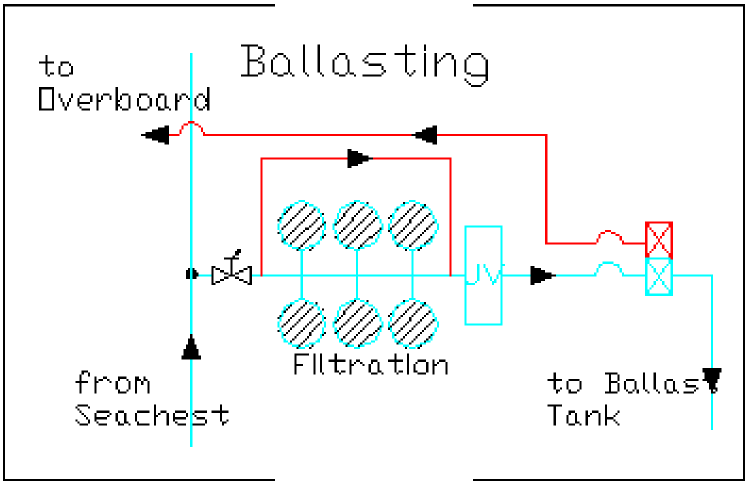

Figure 4.7-2 Ballasting process

pumped out to the overboard through the UV chamber to make sure the microorganisms is sufficiently killed.

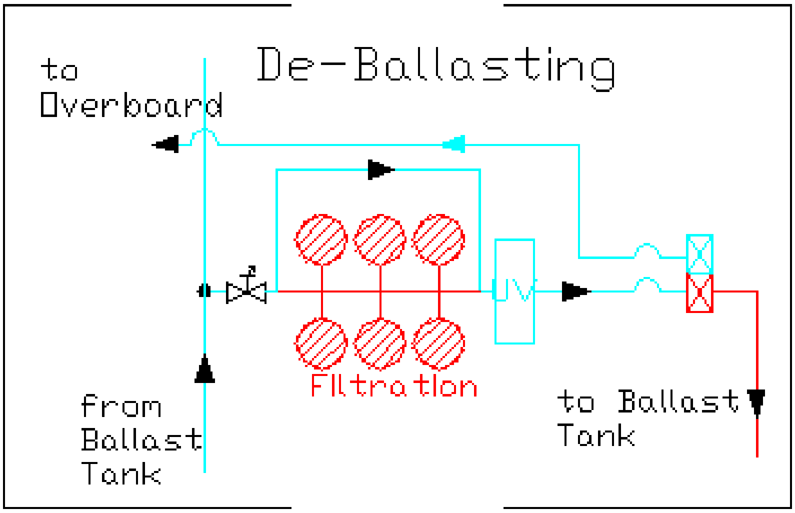

Figure 4.7-1 Deballasting process

The detail drawing of the keyplan system will be attached in the last page of this report

4.8. Impact of the installation to the existing pump

The addition of new equipment to the existing piping system installation will certainly have an impact on increasing pressure loss and decreasing flowrate. The pressure loss provided by the supplementary equipment depends on the type of equipment.

Determination of the pump head and capacity has been calculated in advance in the design stage so that the pump specs are used. Pump head before addition of installation is equal to 18,6 m

Head needed by the pump could be calculated using formula below :

$$H = Head\ Pressure + Head\ Velocity + Head\ statis + Head\ loss$$

where Head pressure = 0 bar

Head velocity = 0

Head statis = 10 m

4.8.1. Head loss suction

Head loss friction

$$Rn = \frac{Dxv}{u}$$

D = Inside diameter Main Pipe = 0,330 m

v = Velocity of the fluid = 2,110 m/s

u = 0,0000849 cst pd 30oC

= 0.0000849/10^6

= 8,49E-11 m2/s

Rn = ((0,330) x 2,11) / 8.49E-11

= 5.28E+09 (turbulent)

In calculation of loses due to friction, to find the friction coefficient, if Rn < 2300 (laminer), thus f = Rn/64 and if it is not then f = 0,02+0,0005/D

$$f = 0,02 + \left(\frac{0,0005}{D}\right)$$

$$f = 0,0215$$

$Head\ loss\ friction = f\,\frac{Lv^2}{2Dg}$; L suction side = 152 m

$$Head\ loss\ friction = 0,0215\,\frac{152x(2,11^2)}{2x0,33x9,81}$$

$$Head\ loss\ friction = 2,246\ m$$

$$Head\ loss\ fittings = k\,\frac{v^2}{2g}$$

No	Type	n	k	n x k
1	Butterfly Valve	1	0,68	0,68
2	Butterfly Valve,Remotely	4	0,86	3,44
3	Elbow 90	1	0,45	0,45
4	Flexible Coupling	6	0,46	2,76
5	Flange	6	0,87	5,22
6	Bellmounted pipe end	1	0,05	0,05
7	Strainer	2	1,5	3
8	T joint	8	0,9	7,2
K				22,800

$$Head\ loss\ fittings = 22{,}8\frac{2{,}11^2}{2x9{,}81}$$

$$Head\ loss\ fittings = 5{,}17\ m$$

Total Head suction = Head loss friction + Head loss fittings

Total Head suction = 2,246 + 5,17 m

Total Head suction = 7,42 m

From data obtained , the pressure drop of the filter from Hyde Guardian is equal to 0,6 barg or equal to 6mH. Thus :

Total Head suction = Head loss friction + Head loss fitttings + Pressure drop BWTS

Total Head suction = 7,42 + 6

Total Head suction = 13,42

4.8.2. Head loss discharge

$Head\ loss\ friction = f\,\frac{Lv^2}{2Dg}$; L dicharge side = 25 m

$$Head\ loss\ friction = 0{,}0215\frac{25x(2{,}11^2)}{2x0{,}33x9{,}81}$$

$$Head\ loss\ friction = 0{,}3695\ m$$

$$Head\ loss\ fittings = k\frac{v^2}{2g}$$

No	Type	n	k	n x k
1	Butterfly Valve	2	0,86	1,72
2	SDNRV	1	1,23	1,23
3	Elbow 90	0	0,45	0
4	T joint	2	0,9	1,8
K				4,8

$$Head\ loss\ fittings = 4{,}8\frac{2{,}11^2}{2x9{,}81}$$

$$Head\ loss\ fittings = 1{,}0774\ m$$

Total Head loss discharge = Head loss friction + Head loss fittings
Total Head loss discharge = 0,3965 + 1,0774
Total Head loss discharge = 1,44 m

$$H = Head\ Pressure + Head\ Velocity + Head\ statis + Head\ loss$$
$$H = 0 + 0 + 10 + 13{,}42 + 1{,}44$$
$$H = 24{,}86\ m$$

From the recalculation that has been done, we got the result that Head needed after installation of BWTS is equal to 24,86 m which still can be covered by existing pump. But with the increase in head will further lower the flowrate.

4.8.3. Decreasing in flowrate

From the recalculation results obtained Head pump is 24.86 m. To estimate how much the flowrate decrease pump curve is required

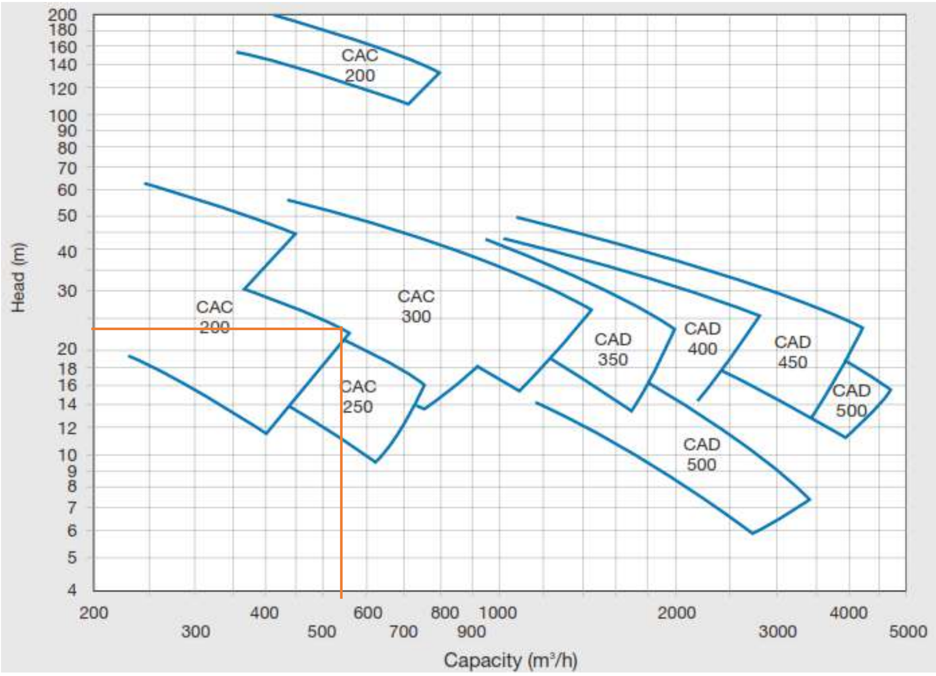

Figure 4.8-1 Pump performance curve

In the pump performance curve chart, the pump head will be inversely proportional to the flowrate. The larger the pump head will be the smaller the flowrate flowed and vice versa. In the graph above can be seen that at Head needs 24.86 m, pump flowrate reduced to 550 m3 / h.

4.8.4. Ballasting time due to decreasing of flowrate

Based on the data obtained, we can calculate the length of time required for ballasting and de-ballasting after the addition of BWTS installation by dividing the total volume of ballast tank to the capacity of the existing pump

$$Q = \frac{V}{t}$$

$$t = \frac{V}{Q}$$

$$= \frac{18205{,}7\ m^3}{1100\ \frac{m^3}{h}}$$

$$= 16{,}55\ h$$

$$= 17\ h$$

The ballasting time required to fill the 100% Load ballast tank is 17 hours, increased 3 hours after installation . This charging time should be adjusted to the time required for the loading and unloading process of the cargo.

The length of loading and unloading process can be predicted by dividing the total volume of cargo with the cargo oil pump capacity. Total volume of cargo tank is 43,413 m3. The number of cargo oil pumps of three with a capacity of 1300 m3 / h each. So that obtained loading and unloading time for 34 hours.

So if the UV Treatment tool is installed, it will not really affect the length of loading and unloading time because the length of time for ballasting or deballasting process is still under the cargo handling process

4.9. Placement of BWTS components

The next stage in the design of the installation of the Ballast Water Treatment system is plotting equipment into the engine room. The thing to watch out for is the available space should be enough to install a new system or equipments. All equipment from the BWTS system will be placed on the floor deck and placed between frame 39 and 43.

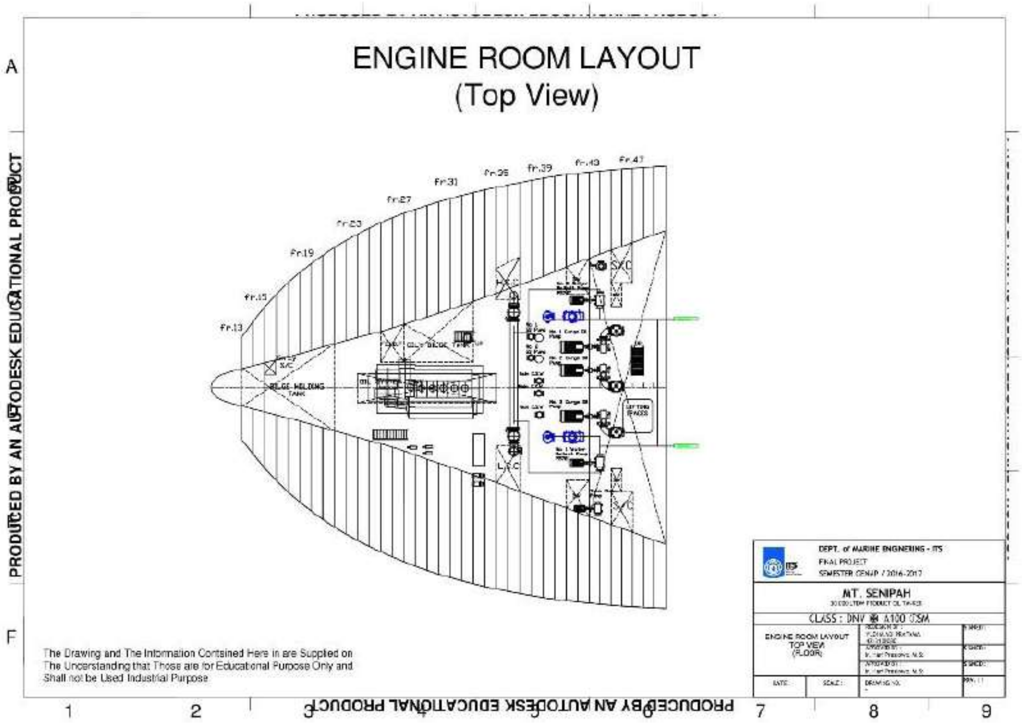

Figure 4.9-1 Engine room layout top view

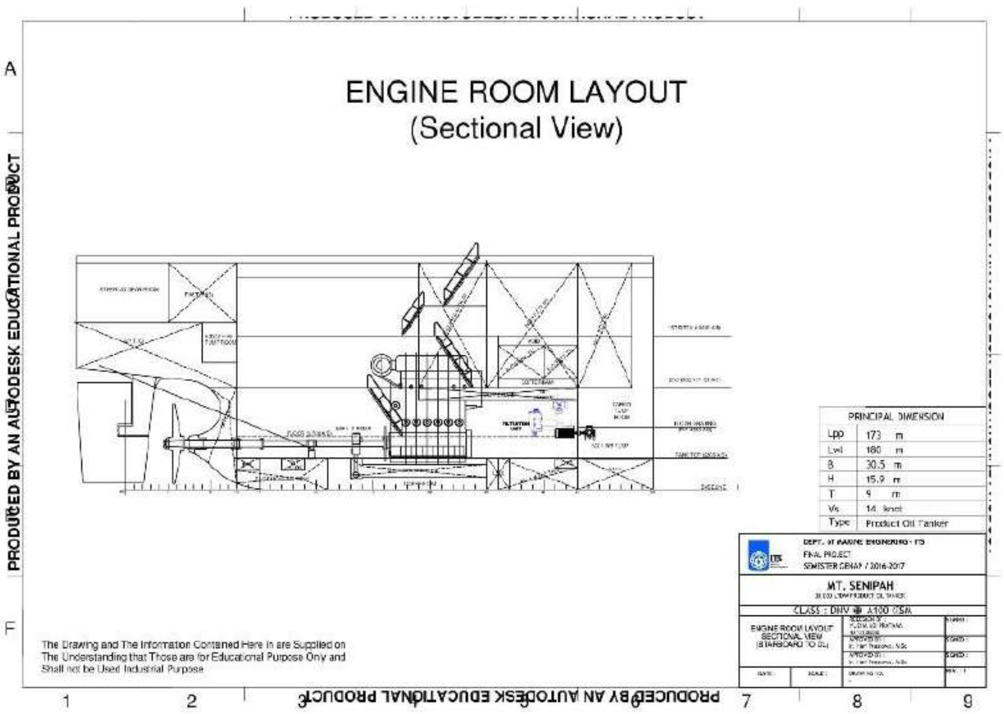

Figure 4.9-2 Engine room layout sectional view

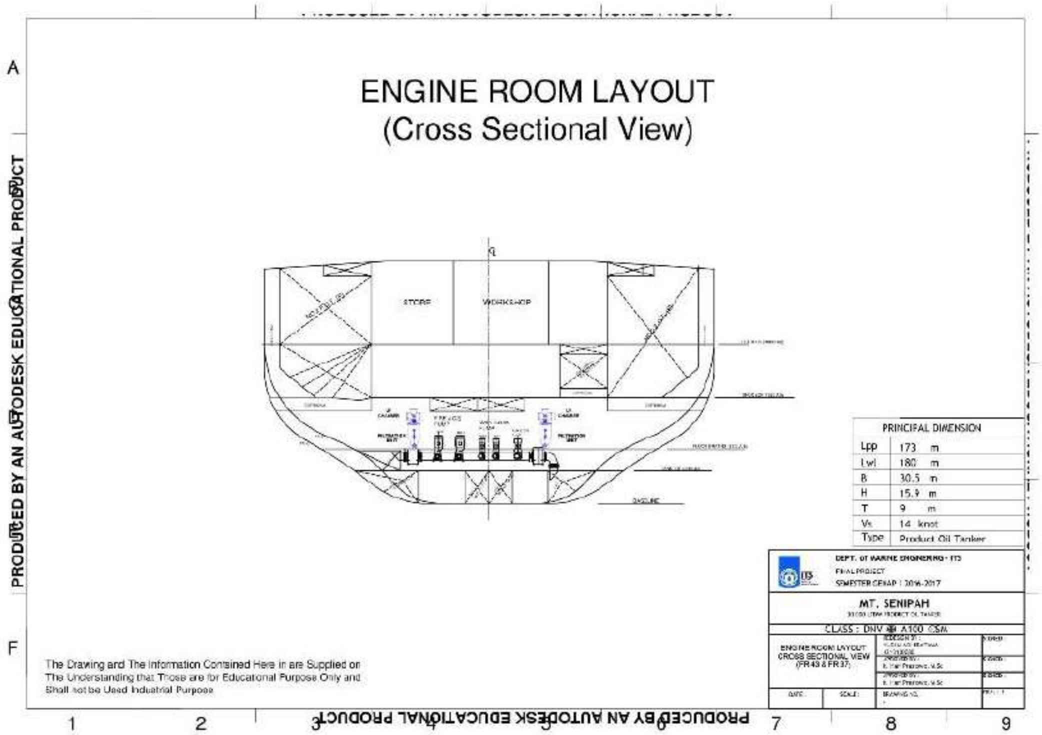

Figure 4.9-3 Engine room layout cross sectional view

4.10. Economic analysis

Economic analysis which will be done is to plan the costs to be incurred including investment costs and operating costs. The planned investment cost includes equipment investment, equipment installation, design cost, etc. As for the operational costs, which includes the cost of replacing UV lamps during the life cycle of the lamp is exhausted and fuel cost due to increasing load factor of the generator.

For the capital cost of the system using UV, it can be calculated by summing the total procurement expenditures for each of the predefined equipment. Capital cost of ballast water treatment is 20,000 USD for every 200 m3 / h. While on this system using ballast treatment with a capacity of 700 m3 / h. So the price of ballast treatment equipment is 70,000 USD.

Table 4.10-1 Capital cost of the systems

JOB NO.	ITEM	QTY	UNIT	VOL	UNIT COST		COST (Rp)	TOTAL COST (Rp)
	BALLAST WATER TREATMENT EQUIPMENT							
1	Ballast Main Pipe	30	m	1	Rp	1250000 / 6 meter	6.250.000	6.250.000
2	Safety Valve	4	pcs	1	Rp	1.062.259	4.249.036	4.249.036
3	Butterfly Valve	5	pcs	1	Rp	3.366.000	16.830.000	16.830.000
4	Remotely Butterfly Valve	5	pcs	1	Rp	4.071.773	20.358.865	20.358.865
5	Control Valve	4	pcs	1	Rp	10.000.000	40.000.000	40.000.000
6	SDNRV	5	pcs	1	Rp	1.303.660	6.518.300	6.518.300
7	T connector	8	pcs	1	Rp	1.331.200	10.649.600	10.649.600
8	90 degree elbow	5	pcs	1	Rp	1.612.431	8.062.155	8.062.155
9	Flange	5	pcs	1	Rp	140.000	700.000	700.000
10	Flexible Coupling	2	pcs	1	Rp	701.830	1.403.660	1.403.660
11	UV Ballast Treatment	2	set	1	Rp	932.469.000	1.864.938.000	1.872.387.300
	Class certificate	1	unit	1	EUR	500	7.449.300	
	TOTAL INVEST COST							1.987.408.916

Purchasing goods abroad require additional cost of shipping costs to get the equipments to Indonesia. It is assumed that UV Ballast treatment is imported from America to Indonesia with shipping cost refers to UPS Worldwide which is Rp 190.320 per kg. So for UV BWTS shipments weighing 2000 kg requires a fee of Rp 380.640.000, -.

Asides of the shipping costs, for goods imported to Indonesia will be charged to some additional cost, there are 10% of entry, 10% for PPn, and 7.5% for PPh.

Table 4.10-2 Total capital costs

BWTS COST ITEMS	TOTAL COST (IDR)
Biaya Desain (7-8%)	139.118.624
Biaya Insurance (0,5%)	9.324.690
Biaya Shipping	**380.640.000**
Total parts	**2.262.351.990**
Bea Cukai (10%)	**186.493.800**
Total parts + Bea masuk	**2.448.845.790**
PPn (10%)	**244.884.579**
PPh (7,5%)	**183.663.434**
Net Total	**3.016.512.427**

So obtained the total cost of procurement for ballast treatment system using UV of Rp 3,016,512,427, -

The installation cost the of equipment in the vessel is obtained by calculating the installation price per equipment adjusted to the price contained in the shipyard.

Table 4.10-3 Installation costs

No.	Peralatan	Brand/Spec	Quantitas	Unit	Komponen	Aktivitas	Unit Cost	Cost		
1	Sistem Perpipaan		2	lots	Pipa	Memotong jalur pipa utama ballast existing	3516200/m	7.032.400		
2	Safety Valve	Ø 350 mm	4	pcs	Katup	Memasang safety valve, mengetes *bedding* dari seal				
3	Butterfly Valve	Ø 350 mm	5	pcs	Katup	Memasang butterfly valve, mengetes *bedding* dari seal	1.330.000	6.650.000		
4	Remotely Butterfly Valve	Ø 350 mm	5	pcs	Katup	Memasang remotely butterfly valve, mengetes *bedding* dari seal	1.449.700	7.248.500		
5	SDNRV	Ø 350 mm	5	pcs	Katup	Memasang SDNRV, mengetes *bedding* dari seal	1.580.173	7.900.865		
6	Control Valve	Ø 350 mm	4	pcs	Katup	Memasang Control Valve, mengetes *bedding* dari seal	1.580.173	6.320.692		
7	90 degree elbow	Ø 355,6 mm	5	pcs	Elbow	Memasang elbow, mengetes *bedding* dari seal	312500	1.562.500		
8	Tee connector	Ø 355,6 mm	8	pcs	T	Memasang T, mengetes *bedding* dari seal	312500	2.500.000		
9	BWT System	700 m3/h	2	set	BWT	Instalasi BWT	8% dari direct	149.195.040		
10	Sistem Perpipaan		30	m		Membuat jalur pipa baru	3516200/m	17.581.000		
							TOTAL	205.990.997		

From the installation price per equipment, the total cost of installation of Ballast Treatment system is Rp 205,990,000.

Operational cost of ballast system could be calculated by analyzing the cost difference of the fuel cost before and after installation of BWTS. The operational cost could be calculated using formula as follows :

$$Wfo = P\ x\ Sfoc\ x\ time\ x\ 10^{-6}\ \ [ton]$$

$$Vfo = \frac{Wfo}{\rho fo}\ [m^3]$$

Description :

Wfo = Weight of fuel [ton]

P = Power Generator [kW]

Sfoc = *spesific fuel oil consumption* [g/kWh]

Time = Time at ports [jam]

<u>Operational cost before installation</u>

$$Wfo = 2153{,}9\ x\ 196\ x\ 34\ x\ 10^{-6}\ \ [ton]$$

$$Wfo = 14{,}35\ \ ton$$

$$Vfo\ = 16{,}89\ m^3$$

$$Vfo\ = 16.890\ L$$

From the above calculation we get the amount of fuel required before the system installation. Assuming that DO fuel price per April 2017 is Rp 8,855, - / L, then the total cost before installation is Rp 149,530,630, -

<u>Operational cost after installation</u>

$Wfo = 2280{,}21\ x\ 196\ x\ 34\ x\ 10^{-6}\ \ [ton]$

$Wfo = 15{,}20\ \ ton$

$Vfo\ = 17{,}87\ m^3$

$Vfo\ = 17.877\ L$

From the above calculation we get the amount of fuel required after the system installation. Assuming that DO fuel price per April 2017 is Rp 8,855, - / L, then the total cost after installation is Rp 158,229,877,-

So the cost difference before and after the installation is the operational cost of the equipment. From the above calculation, the cost difference is Rp 8,769,246.- this operational cost is estimated for one operation of ballasting

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CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The use of ballast water treatment using ultraviolet light is very useful for ships. After doing technical and economical analysis on the installation of ballast water treatment on the ship MT. Senipah, the conclusion is as follows:

1. MT. Senipah might be installed with two UV Ballast Treatment units. At the time of ballasting, the ballast water will be processed through the filtration unit first then into the UV chamber. While at the time of deballasting, the water from the ballast tank will be directly passed through the UV chamber to ensure the microorganisms can not survive anymore before being removed through the overboard
2. Installation of this system gives impact to the increase of generator load factor from 82.8% to 87.7%. The ballast pump head raised to 24.86 m with the decreased flowrate to 550m3 / h and the ballasting time from 14 hours to 17 hours. The UV Treatment will be installed above the floor deck on frames 37 to 43. The available space for maintenance and operation of the engine room is still sufficient to be added
3. Estimation of the investment cost required to add this system is Rp 3,016,512,427 with installation cost is Rp 205,990,000 and operational cost is Rp 8,769,246 for one time operation

5.2. Recommendations

1. Further studies and direct visits to MT Senipah vessels are required to design the system in accordance with the layout of the engine room in order to be applied in real terms
2. Further analysis of the effectiveness of UV tools is needed to ensure that the content of microorganisms in the ballast water is in compliance with the IMO BWMC standard
3. Further economic analysis is required to project whether or not UV Treatment tools should be installed on board or better use the treatment facilities provided by ports

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REFERENCES

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Bolch CJ, Hallegrael GM . 1993 . Chemical and physical treatment options to kill toxic dinoflaglae cycsts in ships ballast water

IMO , 1997. ''Guidelines for the control and management of ships ballast water to minimize the transfer of harmful aquatic organisms and pathogens''. Resolution A.868(20) adopted on November 2997

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ATTACHMENTS

1. LIST OF CODE / REFERENCE USED
a. BKI Rules Vol. III Section 11
b. Roy L Harrington, Marine Engineering
c. Machinery Outfitting Design Manual Vol. I
d. Marine Auxiliary Machinery 7th Edition
e. Marine Auxiliary Machinery and System, M. Khetagurov

2. CALCULATION ALGORITHM
a. Calculation of volume displacement
b. Calculation of Displacement
c. Calculation of capacity ballast pumps
d. Calculation of the main pipe diameter ballast
e. Ballast pump head calculation
- Calculation of the installation in engine room
- Calculation of head at the suction pipe
- Calculation of head at the discharge pipe
- Calculation of total head losses

3. DESIGN PARAMETER INPUT
a. - Calculation of the installation in engine room
Lwl = length of water line
B = breadth moulded
T = draught
Cb = coefficient block
b. Calculation of Displacement
∇ = displacement volume
ρ = density of sea water
c. Calculation of capacity ballast pumps
V = volume of sea water for ballast
t = time required to empty the ballast tank
d. Calculation of the main pipe diameter ballast
Q = ballast pump capacity
v = flow velocity
e. Ballast pump head calculation
- Calculation of the installation in engine room
hs = static head of pump
hp = head pressure
hv = velocity head
- Calculation head at the suction pipe (hl1)
v = viscosity
Rn =reynould number
λ = friction losses

mayor losses = head because long suction pipe
minor losses = head because there ada acessoris to the suction pipe
- Calculation of head at the discharge pipe (hl2)
  v = viscosity
  Rn =reynould number
  λ = friction losses

mayor losses = head because long suction pipe
minor losses = head because there ada acessoris to the suction pipe
- The Calculation of total head losses (Hl)
  hs = static head of pump
  hp = head pressure
  hv = velocity head
  hl1 = head at the suction pipe
  hl2 = head at the discharge pipe

4. DESIGN PARAMETER OUTPUT

a. Calculation of volume displacement
  ∇ = volume displacement

b. Calculation of Displacement
  Δ = displacement

c. Calculation of capacity ballast pumps
  Q = ballast pump capacity

d. Calculation of the main pipe diameter ballast
  dH = internal diameter main pipe ballast

e. Ballast pump head calculation
- Calculation of the installation in engine room
  hs = static head of pump
  hp = head pressure
  hv = velocity head
- Calculation head at the suction pipe (hl1)
  hl1 = head at the suction pipe
- Calculation head at the discharge pipe (hl2)
  hl2 = head at the discharge pipe
- Calculation of total head losses (Hl)
  Hl = total head losses

5. CALCULATION DETAILS

a. Calculation of volume displacement

LWL =	173	m
B =	30,5	m
T =	9	m
Cb =	0,8	

∇ = Lwl x B x T x Cb
∇ = 173 x 30,5 x 9 x 0,8
∇ = 37990,80 m^3

b. Volume of Ballast Tank

The total design volume for ballast tank in MT. Senipah is
Volume of Ballast Tank = 18205,7 m3

c. Capacity ballast pumps

MT. Senipah has two independent ballast pump with capacity of 10 jam
so that the pump capacity

Q = 1300 m^3/hr
Q = 0,36111111 m^3/s
Time needed for ballastir = 14,00 h

d. Calculation of the main pipe diameter ballast

Q = A x v

where A = pipe area= $\frac{1}{4} \times \pi \times D^2$
v = flow velocity (2~4) m/s, takken = 3 m/s

Q = A x v
Q = π x d^2 / 4 x v

$$d = \sqrt{\frac{(Q \times 4)}{\pi \times v}}$$

$$d = \sqrt{\frac{0.08 \, x \, 4}{3.14 \, x \, 3}}$$

d = 0,3916 m
d = 391,584 mm
d = 15,4167 inch

The spesifications of installed ballast pipes are

Inside Diameter	=	13,208	Inch	=	330,2	mm
Branch pipe Diameter		12,556	Inch	=	313,9	mm

e. Ballast pump head calculation

$H = H_s + H_P + H_V$ + total Head-loss

where,

Hs = Distance from suction well to overboard

= 10 m

Hp = (Pdiscd - P suct) / ρg

0 bar, because pressure in suction and discharge side is same

Hv = (V^2disch - V^2suct) / 2g

= (3^2 - 3^2) / (3x 9.81)

= 0

Total Head Loss = H suction + H discharge

***). Head Suction Side**

Head Loss friction

Rn = (D x V) / υ

where ;

D = Inside diameter Main Pipe = 0,330 m

V = Velocity of the fluid = 2,110 m/s

υ = 0,0000849 cst pd 30oC

= 0.0000849/10^6

= 8,49E-11 m^2/s

Rn = ((0.1854) x 3,138) / 8.49E-11

= 8206383981 = 5.28E+0 (turbulent)

For the frictional losses (l) will be determned if the value of reynold number < 2300 (laminer) will be used formula Re/64, and if not the following formula is 0.02 + 0.0005/D

f = 0.02 + 0.0005/D

= 0.02 + 0.0005 / 0.258

= 0,021514234

Head loss friction = f x L x v2 / (D x 2g)

Where;

L = Pipe length suction side = 152 m

hf = 0.02193 x 133.68 x 1.472^2 / (0.258x 2 x 9.81)

= 2,2473 m

Head loss fittings

No	Type	n	k	n x k
1	Butterfly Valve	1	0,68	0,68
2	Butterfly Valve,Remotely	4	0,86	3,44
3	Elbow 90	1	0,45	0,45
4	Flexible Coupling	6	0,46	2,76
5	Flange	6	0,87	5,22
6	Bellmounted pipe end	1	0,05	0,05
7	Strainer	2	1,5	3
8	T joint	8	0,9	7,2
K				22,800

hm = K x V^2 / 2g

= 36.730 x 1.472^2 / (2 x 9.81) m

= 5,17 m

- Total Head Loss for Suction Line

: Head Loss friction + Head Loss Fittings

: 7,42 m

***). Head Discharge Side**

Head loss friction = f x L x v2 / (D x 2g)

Where;

L = Pipe length discharge side : 25,00 m

hf = (0.0219 x 31.34 x 1.472^2) / (0.258 x 2 x 9.81)

= 0,3696 m

Head loss fittings

No	Type	n	k	n x k
1	Butterfly Valve	2	0,86	1,72
2	SDNRV	1	1,23	1,23
3	Elbow 90	0	0,45	0
4	T joint	2	0,9	1,8
K				4,8

hm = K x V2 / 2g
= (5.7 x 1.472^2) / (2 x 9.81)
= 1,0779 m

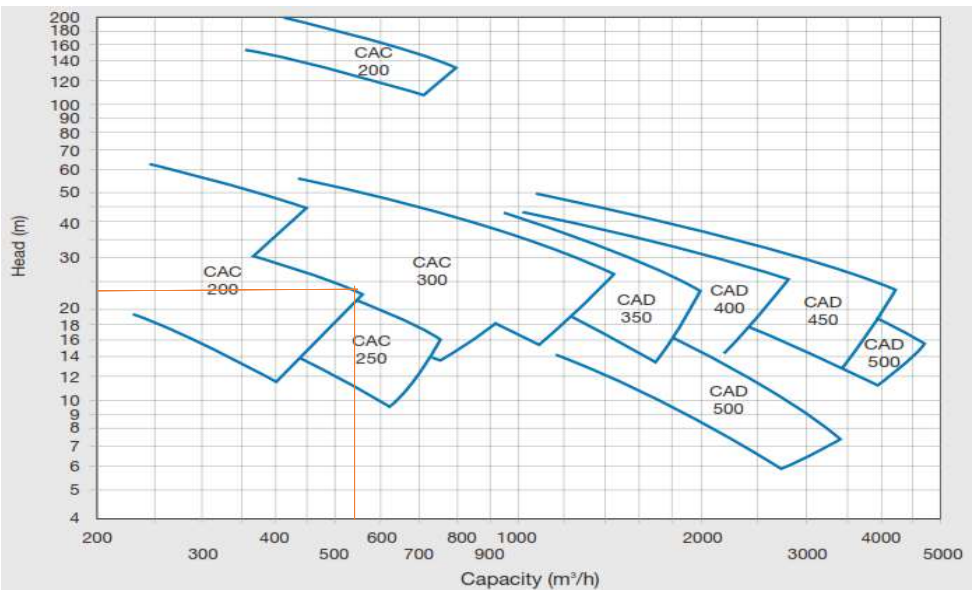
the pressure loss of BWTS approximately between 0,3-0,7 bar, which means the total pressure of dicharge is the sum of head loss due to fittings and friction + pressure loss of BWTS

Total Head-loss discharge = Head loss friction + Head loss fittings + Head loss BWTS
= 1.82+1.94
= 7,4475 m

$H = Hs + H_P + H_V$ + total Head-loss
= 10 + 0 + 0 + 15.71 +3.77
= 24,86845 m

from the re-calculation of Head needed for transferring the ballast water by the pump, the value of Head pump is 24,86 m which is still covered by th head of existing pump. So that it does not need to change the existing pump due to the installaton of BWTS

Due to the increasing of Head pump, the flowrate of the pump will be decrease. We can predict the reducing of flowrate by using the pump performance curve



From the graph, we can see that the flowrate for 24,86 mH is 550 m3/h

ITS Institut Teknologi Sepuluh Nopember	CALCULATION OF GENERATOR LOAD	Project : Final project Doc. No : 01 - 42 13 080 Rev. No : 00 Page : 1

	NO. 1 GENERATOR	NO. 2 GENERATOR	NO. 3 GENERATOR	EM'CY GENERATOR	REMARK
MODEL/TYPE					
RATING	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	
OUTPUT	1625 KVA(1300KW)	1625 KVA(1300KW)	1625 KVA(1300KW)	187,5 KVA(150KW)	
POWER FACTOR	0,8	0,8	0,8	0,8	
VOLTS	AC 445 V	AC 445 V	AC 445 V	AC 445 V	
AMPERES	2108,3 A	2108,3 A	2108,3 A	2108,3 A	
NO. OF PHASES	3 PHASES	3 PHASES	3 PHASES	3 PHASES	
FREQUENCY	60 HZ	60 HZ	60 HZ	60 HZ	
NO. OF POLES	10P	10P	10P	4P	

LOAD FACTOR GENERATOR BEFORE INSTALLATION OF BWTS

		NORMAL SERVICE	DEP. & ARR/PORT	NAV. WITH TANK CLEAN	CARGO SERVICE	HARBOUR SERVICE	EM'CY SERVICE	
							BLACKOUT	FIRE
CONTINUOUS LOAD (KW)		500,4	500,4	625,3	1727,4	225,6	102,1	117,5
INTERMITTENT LOAD	TOTAL (KW)	522,1	649,4	512,8	639,8			
	DIVERSITY FACTOR	1,5	1,5	1,5	1,5	1,5		
	REQUIRED POWER	348,0	432,9	341,8	426,5	382,1		
TOTAL REQUIRED POWER (KW)		848,4	933,3	967,1	2153,9	607,7	102,1	117,5
OUTPUT OF GENERATOR (KW)		1300 KW x 1	1300 KW x 1	1300 KW x 1	1300 KW x 2	1300 KW x 1	150 KW x 1	150 KW x 1
LOAD FACTOR OF GENERATOR		65,3%	71,8%	74,4%	82,8%	46,7%	68,1%	78,3%

	CALCULATION OF GENERATOR LOAD	Project : Final project Doc. No : 01 - 42 13 080 Rev. No : 00 Page : 2

Load factor before Installation		82,8%
P output of equipment	=	75
Effisiensi	=	0,95
P input	=	P output / Eff
P input	=	78,947368
Load factor	=	0,8
Total Load	=	2

Power (Intermittent Load)	=	Load factor x total load x P input	
Power (Intermittent Load)	=	126,31579	kW
Total Power needed when cargo handling	=	2280,2158	kW
Load factor after Installation	=	87,700607	%

LOAD FACTOR GENERATOR AFTER INSTALLATION OF BWTS

		NORMAL SERVICE	DEP. & ARR/PORT	NAV. WITH TANK CLEAN	CARGO SERVICE	HARBOUR SERVICE	EM'CY SERVICE	
							BLACKOUT	FIRE
CONTINUOUS LOAD (KW)		500,4	500,4	625,3	1727,4	225,6	102,1	117,5
INTERMITTENT LOAD	TOTAL (KW)	522,1	649,4	512,8	639,8			
	DIVERSITY FACTOR	1,5	1,5	1,5	1,5	1,5		
	REQUIRED POWER	348,0	432,9	341,8	426,5	382,1		
POWER (KW)		848,4	933,3	967,1	2280,215789	607,7	102,1	117,5
GENERATOR (KW)		1300 KW x 1	1300 KW x 1	1300 KW x 1	1300 KW x 2	1300 KW x 1	150 KW x 1	150 KW x 1
GENERATOR		65,3%	71,8%	74,4%	87,7%	46,7%	68,1%	78,3%

	CALCULATION OF GENERATOR LOAD	Project : Final project Doc. No : 01 - 42 13 080 Rev. No : 00 Page : 3

LOAD ANALYSIS AT START CONDITION

At the start condition, all components of that rotates currents start to have that magnitude 3 times the nominal current. Start current is directly proportional to the power at a constant voltage. In other words, if the current start 3 times the nominal current magnitude of the charge in the state as well start at 3 times of its original power. In this case the analysis is limited to equipment loading and unloading only.

Ship type	= Product Oil Tanker			
Cargo handling equipment	= Cargo Pump (3)			
Power @ Cargo Pump input	=	575,00 kW		
Load factor Cargo Pump	=	0,85		
The total load loading and unloading	=	total power load - load Cargo Pump power		
	=	2280,22	-	1725
	=	555,22 kW		
Start power for 1 Cargo Pump	=	[1 x (Power of Cargo Pump x lf. Cargo Pump)] + [3 x (Power of Cargo Pump x lf. Cargo Pump)]		
	=	[1 x (575 x 0.85)] + [3 x (575 x0.85)]		
	=	2443,75 kW		
So, start power	=	The total load of loading and unloading (without Cargo Pump) + The start for 1 Cargo Pumps		
	=	555,22	+	2443,75
	=	2998,97		

Presentation values of the 3 generators are $= \dfrac{2998,97}{3 \quad x \quad 1300} =$ 77 %

So to anticipate the start current, at the starting point it is recommended to use 3 available generators. Thus, the load factor for the 3 generators becomes 77%. After all equipment of cargo handling is turned on, it can use 2 available generator .

		MATERIAL REQUIREMENT PLAN		Project : Final project Doc. No : 01 - 42 13 080 Rev. No : 00 Page : 1
NO.	**Code**	**WORK BREAK DOWN**	**SPECIFICATION**	**VOLUME**

MATERIAL AND EQUIPMENT

NO.	Code		WORK BREAK DOWN	SPECIFICATION	VOLUME
1.	**PIPING, VALVE, & FITTINGS.**				
	Y	100	**Ballast Piping & Fitting**		
	Y	101	Main Ballast Pipe	Carbon Steel Galvanized, JIS G 3452 SGP-E, 350 A, 355.56mm dia	30 lots
	Y	102	90° elbow (Bllast water treatment)	Wought Carbon Steel Butt Weld, JIS B2312 Standard, 350A, 355,6 mm dia	5 pcs
	Y	103	Flange	Carbon steel, JIS 5K Standard, 350, 358,1 mm dia	5 pcs
	Y	104	Tee	Carbon steel, JIS 5K Standard, 350, 358,1 mm dia	8 pcs
	Y	105	Bulkhead Fitting Watertight Flange	Stainless steel, 360 mm dia	2 pcs
	Y	106	Flexible Coupling	Victaulic standard Flexible Coupling	2 pcs
	Y	200	**VALVE**		
	Y	201	Safety Valve (Ballast Water Treatment)	Bronze G-CuSn5ZnPb (RG 5), 350 mm dia	4 pcs
	Y	202	Butterfly Valve (Ballast Water Treatment)	Bronze (RG 5), 350 mm dia	5 pcs
	Y	203	Remotely Butterfly Valve (Ballast Water Treatment)	Bronze (RG 5), 350 mm dia	5 pcs
	Y	204	Screw Down Non Return Valve (Ballast Water Treatment)	Bronze (RG 5), 350 mm dia	5 pcs
	Y	205	Control Valve (Pressure Reducer)	Bronze (RG 5), 350 mm dia	4 pcs

2	**MACHINERY PART**				
	A	100	**Ballast Water Treatment**		
	A	101	Filter	FC 300, 700m3/h, IP 44	2 unit
	A	102	UV Chamber	UV20 B, 700m3/h, IP 44	2 unit
	A	103	Control Cabinet	Hyde Guardian Marine	2 unit
	A	104	Power Panel	Hyde Guardian Marine	2 unit
	A	105	Booster Pump	Hyde Guardian Marine	2 unit
	A	106	Foundation for BWTS	Carbon Steel Plate, thick 8mm	2 unit

CAPITAL EXPENDITURE

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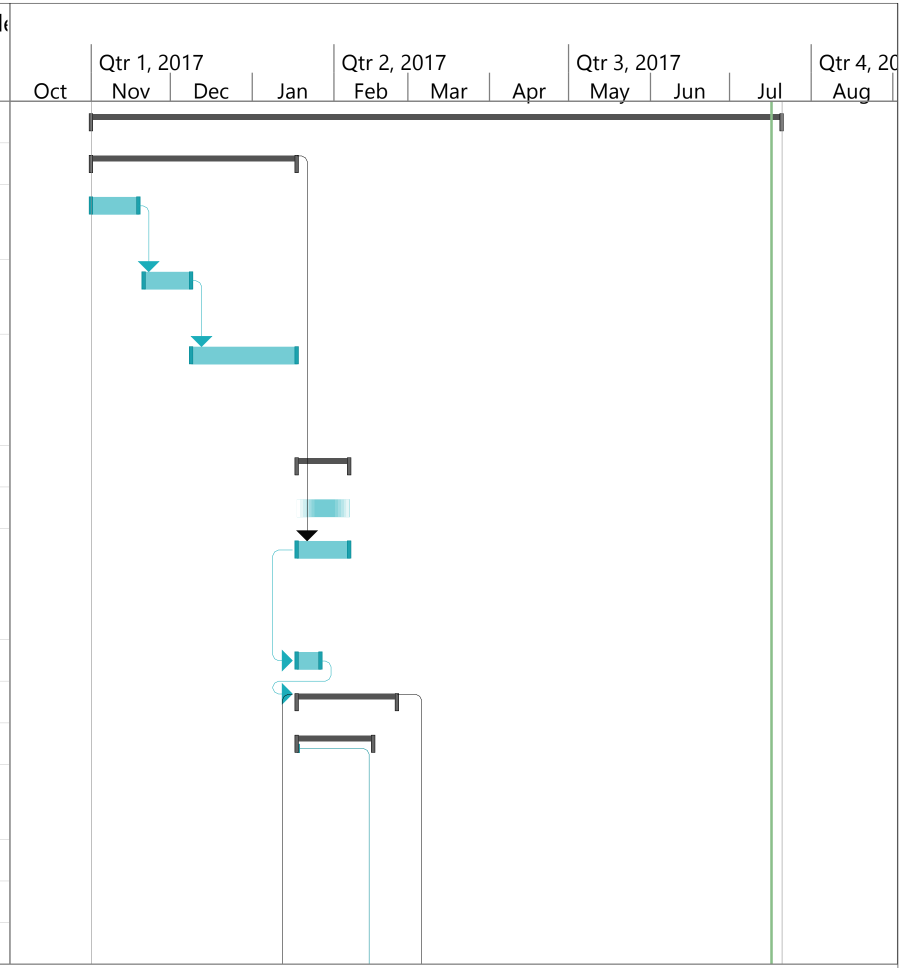
JOB NO.	ITEM	QTY	UNIT	VOL	UNIT COST		COST (Rp)	TOTAL COST (Rp)
	BALLAST WATER TREATMENT EQUIPMENT							
1	Ballast Main Pipe	30	m	1	Rp	1250000 / 6 meter	6.250.000	6.250.000
2	Safety Valve	4	pcs	1	Rp	1.062.259	4.249.036	4.249.036
3	Butterfly Valve	5	pcs	1	Rp	3.366.000	16.830.000	16.830.000
4	Remotely Butterfly Valve	5	pcs	1	Rp	4.071.773	20.358.865	20.358.865
5	Control Valve	4	pcs	1	Rp	10.000.000	40.000.000	40.000.000
6	SDNRV	5	pcs	1	Rp	1.303.660	6.518.300	6.518.300
7	T connector	8	pcs	1	Rp	1.331.200	10.649.600	10.649.600
8	90 degree elbow	5	pcs	1	Rp	1.612.431	8.062.155	8.062.155
9	Flange	5	pcs	1	Rp	140.000	700.000	700.000
10	Flexible Coupling	2	pcs	1	Rp	701.830	1.403.660	1.403.660
11	UV Ballast Treatment	2	set	1	Rp	932.469.000	1.864.938.000	1.872.387.300
	Class certificate	1	unit	1	EUR	500	7.449.300	
	TOTAL INVEST COST							**1.987.408.916**

BWTS COST ITEMS	TOTAL COST (IDR)
Biaya Desain (7-8%)	139.118.624
Biaya Insurance (0,5%)	9.324.690
Biaya Shipping	**380.640.000**
Total parts	**2.262.351.990**
Bea Cukai (10%)	**186.493.800**
Total parts + Bea masuk	**2.448.845.790**
PPn (10%)	**244.884.579**
PPh (7,5%)	**183.663.434**
Net Total	**3.016.512.427**

	CAPITAL EXPENDITURE					Project : Final project Doc. No : 01 - 42 13 080 Rev. No : 00 Page : 1		
BWT SYSTEM								
					Activities			
No.	**Peralatan**	**Brand/Spec**	**Quantitas**	**Unit**	**Komponen**	**Aktivitas**	**Unit Cost**	**Cost**
1	Sistem Perpipaan		2	lots	Pipa	Memotong jalur pipa utama ballast existing	3516200/m	7.032.400
2	Safety Valve	Ø 350 mm	4	pcs	Katup	Memasang safety valve, mengetes *bedding* dari seal		
3	Butterfly Valve	Ø 350 mm	5	pcs	Katup	Memasang butterfly valve, mengetes *bedding* dari seal	1.330.000	6.650.000
4	Remotely Butterfly Valve	Ø 350 mm	5	pcs	Katup	Memasang remotely butterfly valve, mengetes *bedding* dari seal	1.449.700	7.248.500
5	SDNRV	Ø 350 mm	5	pcs	Katup	Memasang SDNRV, mengetes *bedding* dari seal	1.580.173	7.900.865
6	Control Valve	Ø 350 mm	4	pcs	Katup	Memasang Control Valve, mengetes *bedding* dari	1.580.173	6.320.692
7	90 degree elbow	Ø 355,6 mm	5	pcs	Elbow	Memasang elbow, mengetes *bedding* dari seal	312500	1.562.500

8	Tee connector	Ø 355,6 mm	8	pcs	T	Memasang T, mengetes *bedding* dari seal	312500	2.500.000
9	BWT System	700 m3/h	2	set	BWT	Instalasi BWT	8% dari direct c	149.195.040
10	Sistem Perpipaan		30	m		Membuat jalur pipa baru	3516200/m	17.581.000
							TOTAL	205.990.997

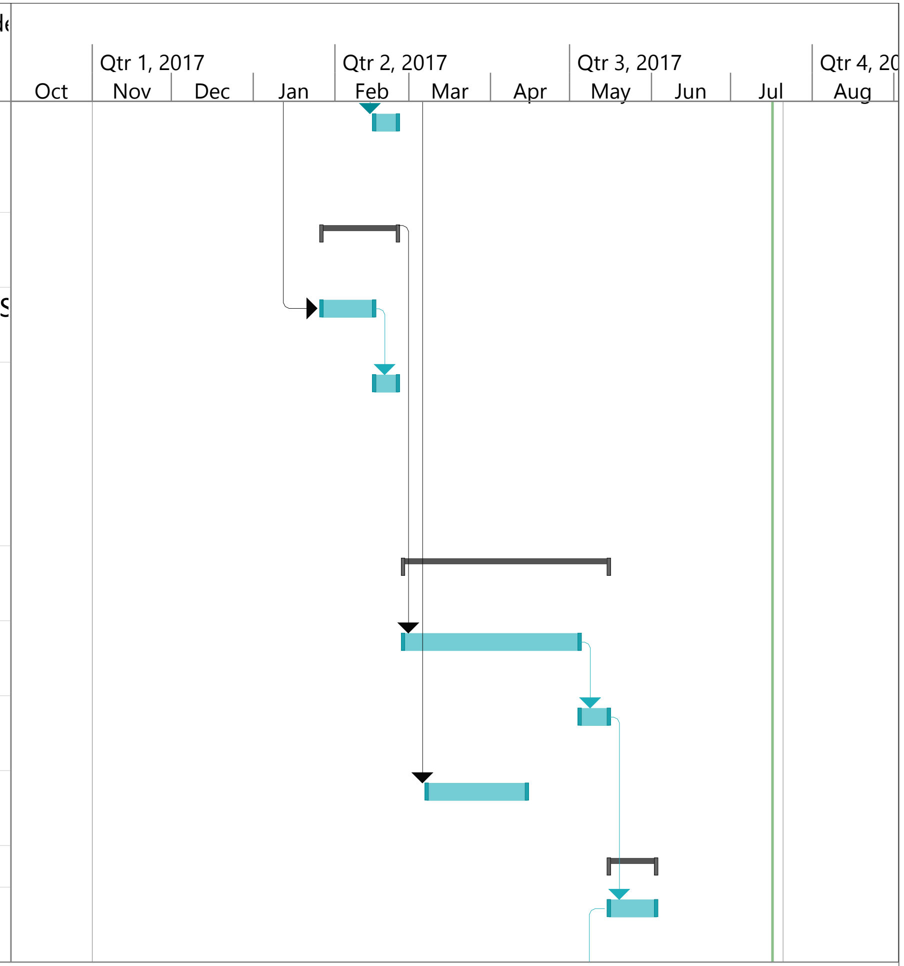
ID	Outline Number	Task Name	Duration	Start	Finish	Prede
1	**1**	**BWTS RETROFIT**	**188 days**	**Tue 01/11/16**	**Thu 20/07/17**	
2	**1.1**	**System Selection**	**56 days**	**Tue 01/11/16**	**Tue 17/01/17**	
3	1.1.1	Type of Technology	2 wks	Tue 01/11/16	Fri 18/11/16	
4	1.1.2	Supplier research	2 wks	Mon 21/11/16	Thu 08/12/16	3
5	1.1.3	Lifecycle operating cost	4 wks	Fri 09/12/16	Tue 17/01/17	4
6	**1.2**	**Pre Engineering**	**14 days**	**Wed 18/01/17**	**Mon 06/02/17**	
7	1.2.1	3d Laser scan	2 wks			
8	1.2.2	Selected system fit the space	2 wks	Wed 18/01/17	Mon 06/02/17	2
9	1.3	Ship Visit	1 wk	Wed 18/01/17	Thu 26/01/17	8SS
10	**1.4**	**Purchase**	**28 days**	**Wed 18/01/17**	**Fri 24/02/17**	**9**
11	**1.4.1**	**Negotiation**	**3 wks**	**Wed 18/01/17**	**Wed 15/02/17**	
12	1.4.1.1	BWT System				
13	1.4.1.2	Valves				
14	1.4.1.3	Pipe				
15	1.4.1.4	Fittings				



Project: 4280_Project.mpp
Date: Mon 17/07/17

Task	Inactive Summary	External Tasks
Split	Manual Task	External Milestone
Milestone	Duration-only	Deadline
Summary	Manual Summary Rollup	Progress
Project Summary	Manual Summary	Manual Progress
Inactive Task	Start-only	
Inactive Milestone	Finish-only	

ID	Outline Number	Task Name	Duration	Start	Finish	Prede
16	1.4.2	Decide place to be delivered	1 wk	Thu 16/02/17	Fri 24/02/17	11
17	**1.5**	**Ship spesific Engineering**	**21 days**	**Fri 27/01/17**	**Fri 24/02/17**	
18	1.5.1	Detailed drawing	2 wks	Fri 27/01/17	Wed 15/02/17	10SS
19	1.5.2	Merged all electrical system and machinery system	1 wk	Thu 16/02/17	Fri 24/02/17	18
20	**1.6**	**Submittal to Class Society**	**56 days**	**Mon 27/02/17**	**Mon 15/05/17**	
21	1.6.1	Reviewed by class	7 wks	Mon 27/02/17	Thu 04/05/17	17
22	1.6.2	Approved by class	1 wk	Fri 05/05/17	Mon 15/05/17	21
23	1.7	Delivery to Shipyard / vessel	4 wks	Wed 08/03/17	Fri 14/04/17	10
24	**1.8**	**Pre-Fabrication**	**14 days**	**Tue 16/05/17**	**Fri 02/06/17**	
25	1.8.1	Clear area to be installed	2 wks	Tue 16/05/17	Fri 02/06/17	22



Project: 4280_Project.mpp
Date: Mon 17/07/17

Task	Inactive Summary	External Tasks
Split	Manual Task	External Milestone
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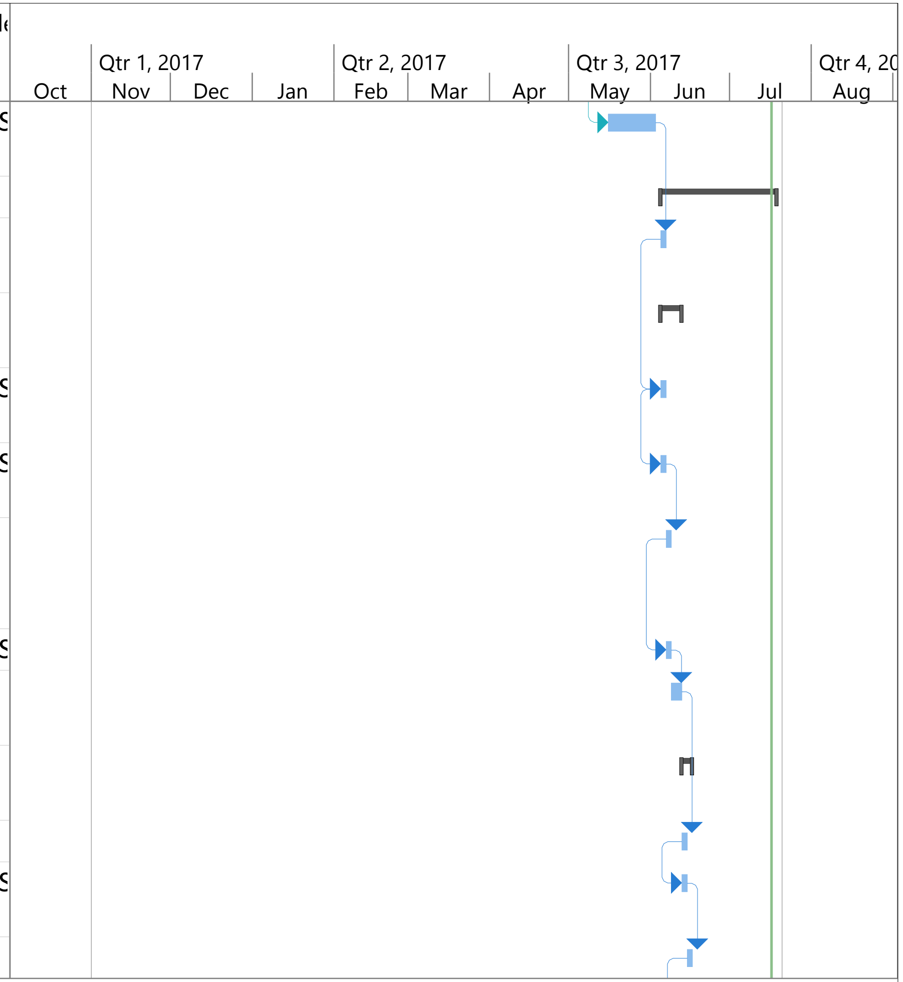
ID	Outline Number	Task Name	Duration	Start	Finish	Prede
26	1.8.2	build pipe spools	2 wks	Tue 16/05/17	Fri 02/06/17	25SS
27	**1.9**	**Installation**	**32 days**	**Mon 05/06/17**	**Tue 18/07/17**	
28	1.9.1	Cutting the existing pipe	2 days	Mon 05/06/17	Tue 06/06/17	26
29	**1.9.2**	**Installation of Valves**	**6 days**	**Mon 05/06/17**	**Mon 12/06/17**	
30	1.9.2.1	Safety Valve	2 days	Mon 05/06/17	Tue 06/06/17	28SS
31	1.9.2.2	Butterfly Valve	2 days	Mon 05/06/17	Tue 06/06/17	30SS
32	1.9.2.3	Remotely butterfly valve	2 days	Wed 07/06/17	Thu 08/06/17	31
33	1.9.2.4	SDNRV	2 days	Wed 07/06/17	Thu 08/06/17	32SS
34	1.9.2.5	Control valve	2 days	Fri 09/06/17	Mon 12/06/17	33
35	**1.9.3**	**Installation of Fittings**	**4 days**	**Tue 13/06/17**	**Fri 16/06/17**	
36	1.9.3.1	Flanges	2 days	Tue 13/06/17	Wed 14/06/17	34
37	1.9.3.2	Flexible Coupling	2 days	Tue 13/06/17	Wed 14/06/17	36SS
38	1.9.3.3	90 Elbow	2 days	Thu 15/06/17	Fri 16/06/17	37



Project: 4280_Project.mpp
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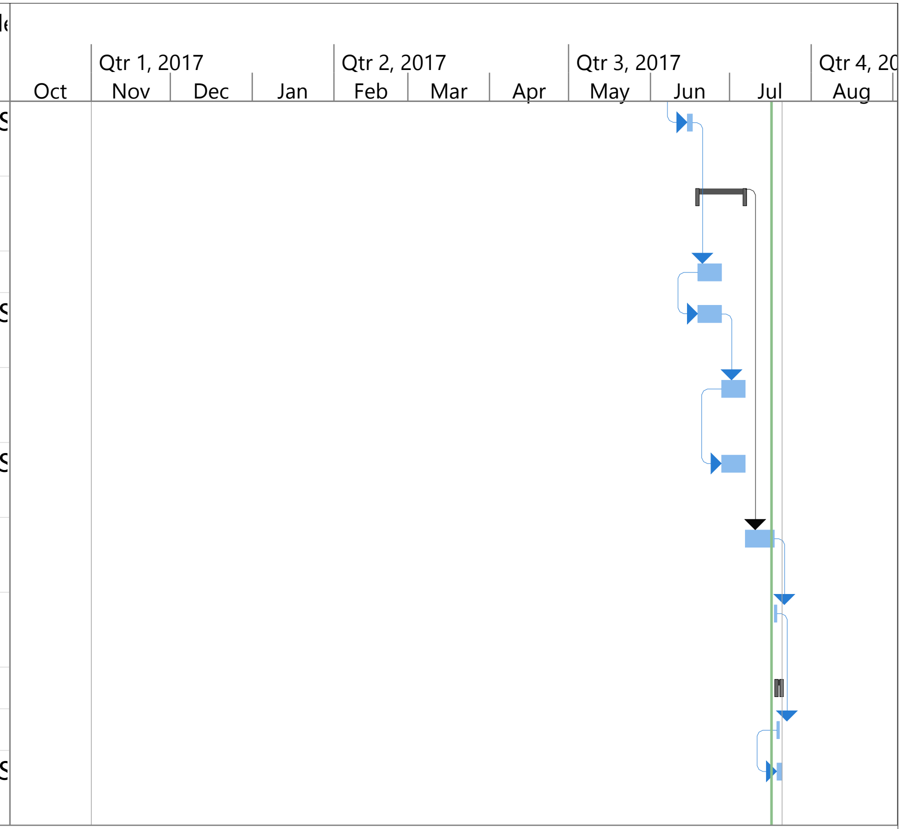
Task	Inactive Summary	External Tasks
Split	Manual Task	External Milestone
Milestone	Duration-only	Deadline
Summary	Manual Summary Rollup	Progress
Project Summary	Manual Summary	Manual Progress
Inactive Task	Start-only	
Inactive Milestone	Finish-only	

ID	Outline Number	Task Name	Duration	Start	Finish	Prede
39	1.9.3.4	T connection	2 days	Thu 15/06/17	Fri 16/06/17	38SS
40	**1.9.4**	**Installation of BWTS System**	**14 days**	**Mon 19/06/17**	**Thu 06/07/17**	
41	1.9.4.1	Filter Unit	1 wk	Mon 19/06/17	Tue 27/06/17	39
42	1.9.4.2	UV Chamber	1 wk	Mon 19/06/17	Tue 27/06/17	41SS
43	1.9.4.3	Power panel	1 wk	Wed 28/06/17	Thu 06/07/17	42
44	1.9.4.4	Control cabinet	1 wk	Wed 28/06/17	Thu 06/07/17	43SS
45	1.9.5	Joining new pipe	1 wk	Fri 07/07/17	Mon 17/07/17	40
46	1.9.6	Integrating the system	1 day	Tue 18/07/17	Tue 18/07/17	45
47	**1.10**	**Commisioning**	**2 days**	**Wed 19/07/17**	**Thu 20/07/17**	
48	1.10.1	Crew Training	1 day	Wed 19/07/17	Wed 19/07/17	46
49	1.10.2	Class Acceptance	2 days	Wed 19/07/17	Thu 20/07/17	48SS



Project: 4280_Project.mpp
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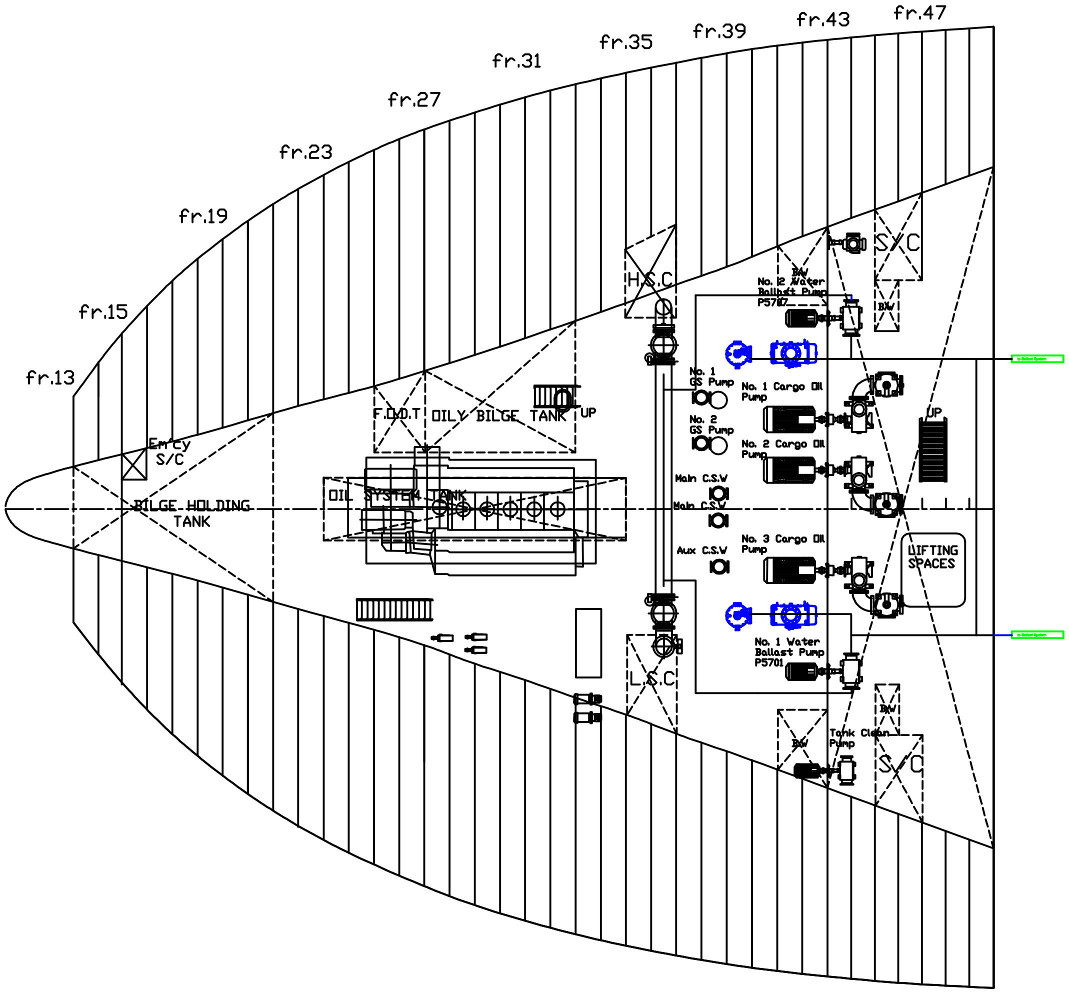
Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

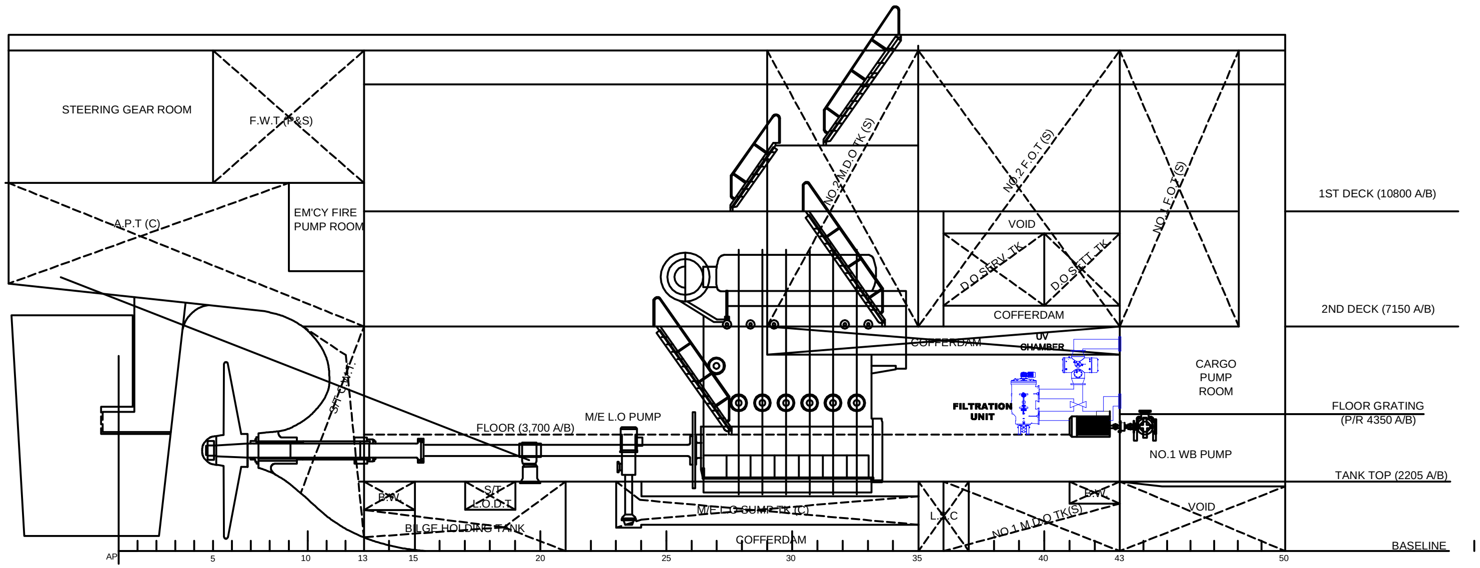
ENGINE ROOM LAYOUT
(Top View)



The Drawing and The Information Contsined Here in are Supplied on The Understanding that Those are for Educational Purpose Only and Shall not be Used Industrial Purpose

DEPT. of MARINE ENGINERING - ITS FINAL PROJECT SEMESTER GENAP / 2016-2017		
MT. SENIPAH 30.000 LTDW PRODUCT OIL TANKER		
CLASS : DNV ✠ A100 ⓘSM		
ENGINE ROOM LAYOUT TOP VIEW (FLOOR)	REDESIGN BY : YUDHA ADI PRATAMA 4213100080	SIGNED :
	APROVED BY : Ir. Hari Prastowo, M.Sc	SIGNED :
	APROVED BY : Ir. Hari Prastowo, M.Sc	SIGNED :
DATE : / SCALE :	DRAWING NO. -	REV. : 1

ENGINE ROOM LAYOUT
(Sectional View)



PRINCIPAL DIMENSION	
Lpp	173 m
Lwl	180 m
B	30.5 m
H	15.9 m
T	9 m
Vs	14 knot
Type	Product Oil Tanker

DEPT. of MARINE ENGINERING - ITS
FINAL PROJECT
SEMESTER GENAP / 2016-2017

MT. SENIPAH
30.000 LTDW PRODUCT OIL TANKER

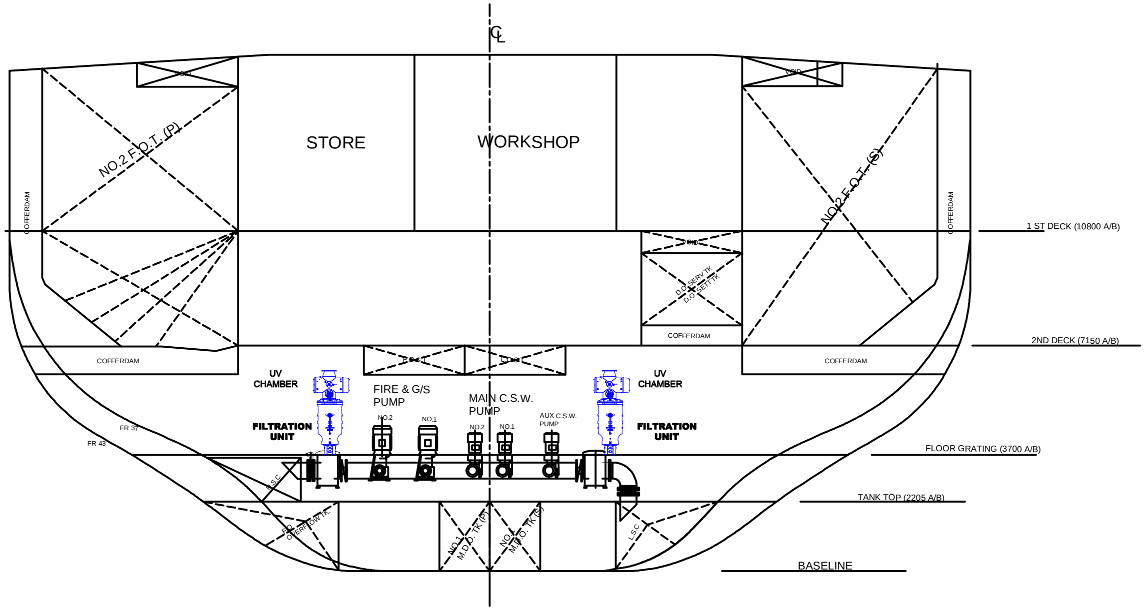
CLASS : DNV A100 ①SM

ENGINE ROOM LAYOUT SECTIONAL VIEW (STARBOARD TO CL)	REDESIGN BY : YUDHA ADI PRATAMA 4213100080	SIGNED :
	APROVED BY : Ir. Hari Prastowo, M.Sc	SIGNED :
	APROVED BY : Ir. Hari Prastowo, M.Sc	SIGNED :
DATE : / SCALE :	DRAWING NO. -	REV. : 1

The Drawing and The Information Contsined Here in are Supplied on The Understanding that Those are for Educational Purpose Only and Shall not be Used Industrial Purpose

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

ENGINE ROOM LAYOUT
(Cross Sectional View)



PRINCIPAL DIMENSION	
Lpp	173 m
Lwl	180 m
B	30.5 m
H	15.9 m
T	9 m
Vs	14 knot
Type	Product Oil Tanker

DEPT. of MARINE ENGINEERING - ITS
FINAL PROJECT
SEMESTER GENAP / 2016-2017

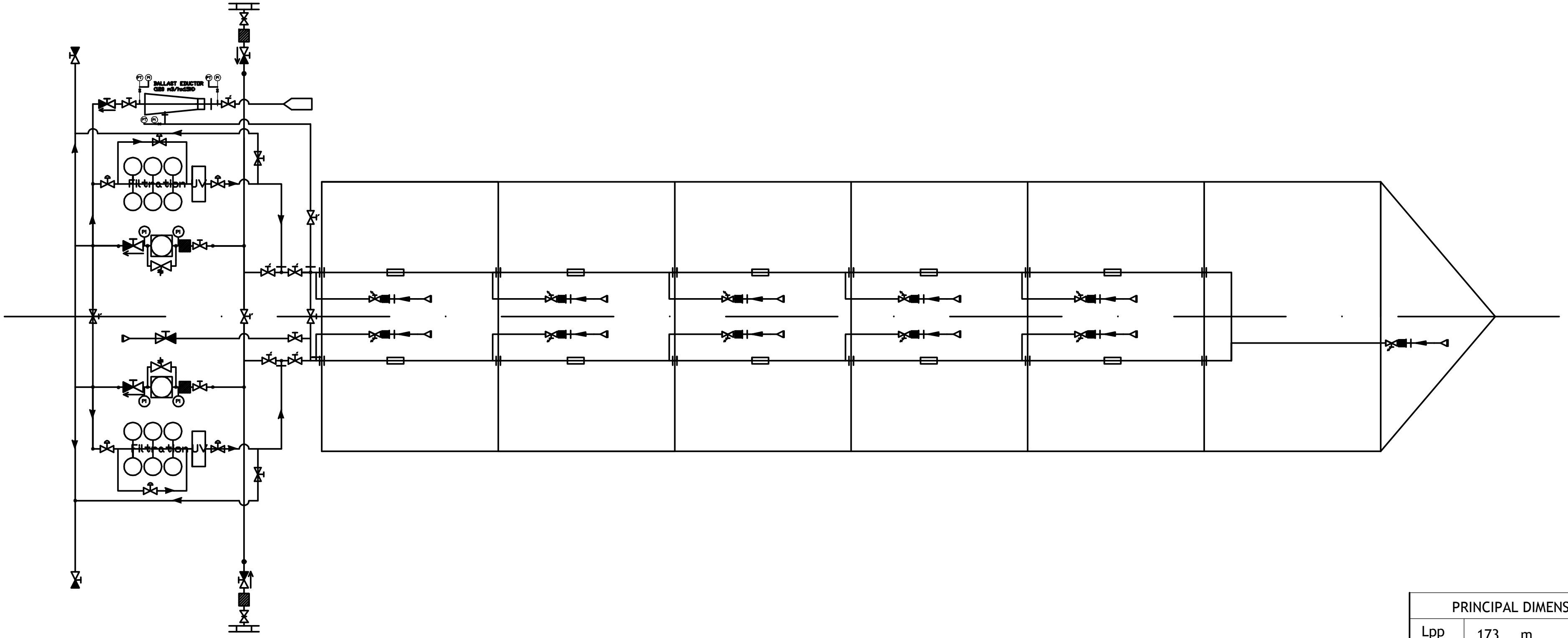
MT. SENIPAH
30.000 LTDW PRODUCT OIL TANKER

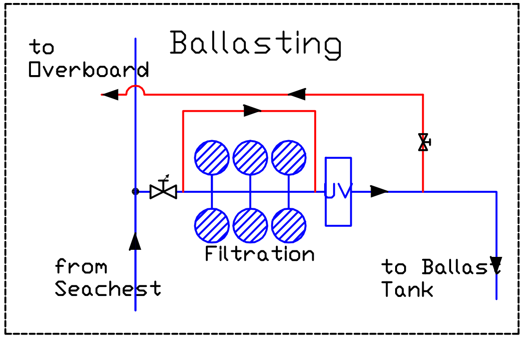
CLASS : DNV ✠ A100 ⒾSM

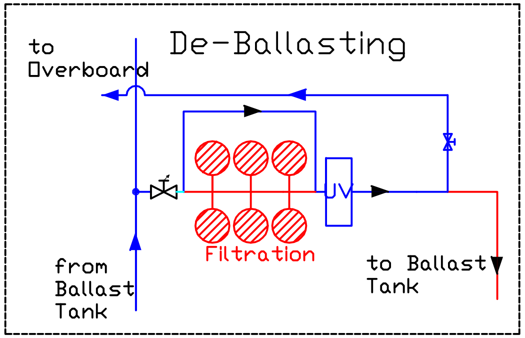
ENGINE ROOM LAYOUT CROSS SECTIONAL VIEW (FR 43 & FR 37)	REDESIGN BY : YUDHA ADI PRATAMA 4213100080	SIGNED :
	APROVED BY : Ir. Hari Prastowo, M.Sc	SIGNED :
	APROVED BY : Ir. Hari Prastowo, M.Sc	SIGNED :
DATE : / SCALE :	DRAWING NO. -	REV. : 1

The Drawing and The Information Contsined Here in are Supplied on The Understanding that Those are for Educational Purpose Only and Shall not be Used Industrial Purpose

MODIFIED PLAN
UV BALLAST WATER TREATMENT SYSTEM







PRINCIPAL DIMENSION	
Lpp	173 m
Loa	180 m
B	30.5 m
H	15,9 m
T	9 m
DWT	29760.2 TON
Vs	14 knot
Type	Product Oil Tanker

NO / SYMBOL	EQUIPMENT	QUANTITY	CODE	SPECT
	GATE VALVE	4	BL-GV	
	SAVETY VALVE	2	BL-SV	
	NON RETURN VALVE	2	BL-NRV	
	NON RETURN VALVE, STRAIGHT, SCREW DOWN	2	BL-NRVSD	
	BUTTERFLY VALVE	21	BL- BFV	
	BATTERFLY REMOTELY	10	BL-BFR	
	BULKHEAD FITTING WATERTIGHT, FLANGE	18	BL- BF	
	BELLMOUTHED	10	BL-BM	
	FLEXIBLE COUPLING	12	BL-FC	
BL	BALLAST PUMP	1		CENTRIFUGAL PUMP CAPACITY 650 M3/H HEAD 25 M
BL	BALLAST PUMP	1		CENTRIFUGAL PUMP CAPACITY 650 M3/H HEAD 25 M
	FILTER/STRAINER	16	BL-F	
PI	PRESSURE INDICATOR	4		

DEPT. of MARINE ENGINEERING - ITS
FINAL PROJECT OF BACHELOR THESIS
SEMESTER GENAP / 2016-2017

MT. SENIPAH
PRODUCT OIL TANKER
OWNER : PERTAMINA

CLASS : DNV AI00 SM P

BALLAST WATER TREATMENT SYSTEM

DRAWING BY :
BIJO ENGINEERING CO.

MODIFIED BY :
YUDHA ADI PRATAMA

APROVED BY :
Ir. Hari Prastowo, M.Sc

SIGNED :

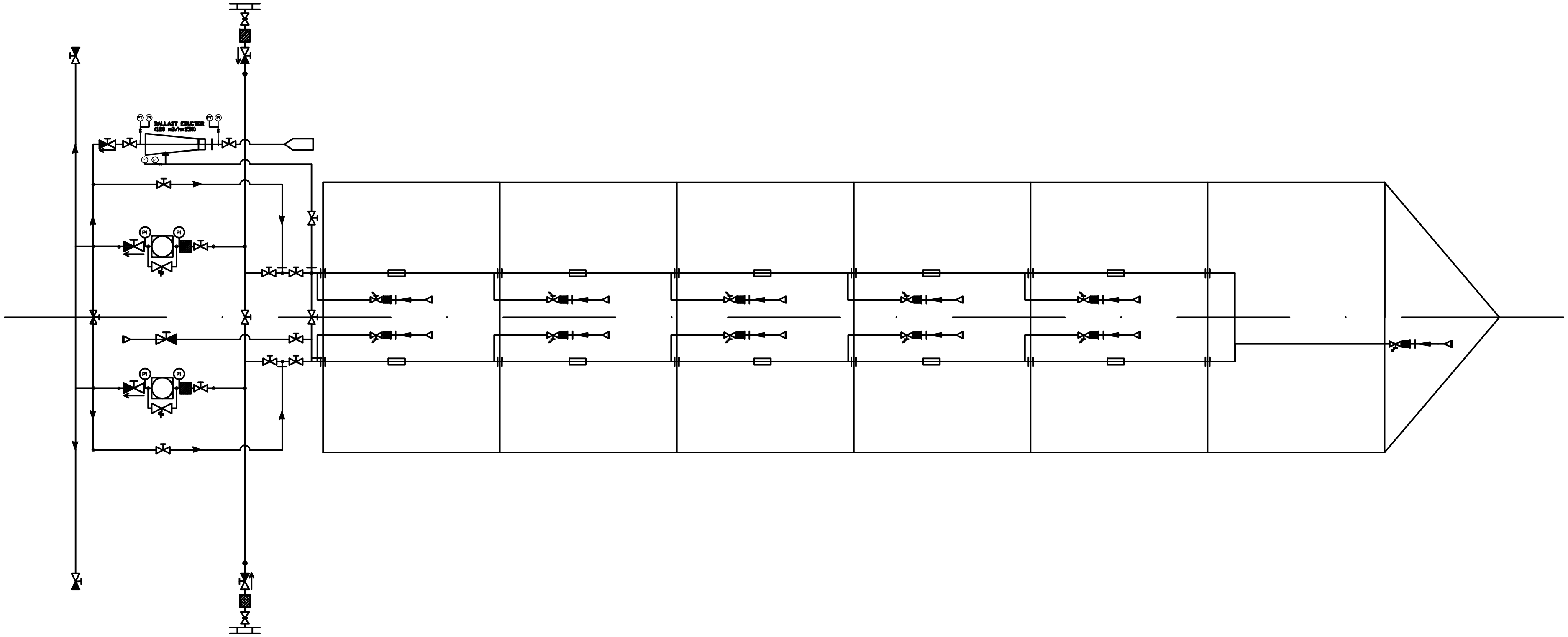
SIGNED :

REV. :

DATE :

SCALE :

EXISTING PLAN
BALLAST SYSTEM



NO / SYMBOL	EQUIPMENT	QUANTITY	CODE	SPECT
	GATE VALVE	4	BL-GV	
	SAVETY VALVE	2	BL-SV	
	NON RETURN VALVE	2	BL-NRV	
	NON RETURN VALVE, STRAIGHT, SCREW DOWN	2	BL-NRVSD	
	BUTTERFLY VALVE	21	BL- BFV	
	BATTERFLY REMOTELY	10	BL-BFR	
	BULKHEAD FITTING WATERTIGHT, FLANGE	18	BL- BF	
	BELLMOUTHED	10	BL-BM	
	FLEXIBLE COUPLING	12	BL-FC	
BL	BALLAST PUMP	1		CENTRIFUGAL PUMP CAPACITY 650 M3/H HEAD 25 M
BL	BALLAST PUMP	1		CENTRIFUGAL PUMP CAPACITY 650 M3/H HEAD 25 M
	FILTER/STRAINER	16	BL-F	
PI	PRESSURE INDICATOR	4		

PRINCIPAL DIMENSION	
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Vs	14 knot
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DEPT. of MARINE ENGINEERING - ITS
FINAL PROJECT OF BACHELOR THESIS
SEMESTER GENAP / 2016-2017

MT. SENIPAH
PRODUCT OIL TANKER
OWNER : PERTAMINA
CLASS : DNV A1 SM P

BALLAST WATER TREATMENT SYSTEM	DRAWING BY : BIJO ENGINEERING CO.	SIGNED :
	MODIFIED BY : YUDHA ADI PRATAMA	SIGNED :
DATE : / SCALE :	APROVED BY : Ir. Hari Prastowo, M.Sc	REV. :

BIOGRAPHY

Yudha Adi Pratama was born in September, 30th 1995 in Serui, Yapen Waropen. He is the first child of a father named Suprayogi, S.Pd. MM and a mother named Dra.Rosmiati Mabuia,M.Pd. Yudha spent six years primary study at SDN Sampang Agung 1 Kutorejo. He enterend his elementary school in 2001 and graduated in 2007. Right after, he had his secondary level of study at SMPN 1 Pacet and graduated in 2010. He, then continued his study to SMAN 1 Sooko, Mojokerto and graduated in 2013. At the same year, he continued his study to Department of Marine Engineering, Institut Teknologi Sepuluh Nopember Surabaya and graduated on September 2017. During his study at ITS, Yudha was actively participated in some organizations and event experiences, such as becoming staff of student executive board at Faculty of Marine Technology in period 2014-2015, Chief of Robotic Boat Competition, Marine Icon 2015-2016, etc. Yudha also participated in some research competition and becoming finalists on GSC (Green Scientific Competition) held in Semarang 2015 and LKTM UNHAS held in Makassar 2016. At his final year of study, he focused on field Marine and Machinery and System and becoming a laboratory assitant of Turbin Pelton in MMS Laboratory.